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THE SHOCK AND VIBRATION DIGEST

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THE SHOCK AND VIBRATION DIGEST

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THE SHOCK AND VIBRATION INFORMATION CENTER

Code 6020 Naval Research Laboratory
Washington, D.C. 20390

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Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers.

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RENEWAL TIME

All subscriptions to the Shock and Vibration Digest are carried on a calendar year basis. To continue to receive the DIGEST without interruption in 1972, all those receiving this issue are requested to notify the Shock and Vibration Information Center before 15 December 1971.

Changes in the funding of the Center require that the subscription rate for 1972 be increased to $25.00 a year, both domestic and foreign. Please send purchase orders or checks with renewals at the new rate.

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EDITORS RATTLE SPACE

DIGITAL COMPUTATION

In my editorial on "Literature Characterization" (Vol. 3, No. 10), I portrayed the digital computer as the cause of diminished innovation in analytical methods. This reduction was asserted to be an effect of the presence of the digital computer in the technology of today: the powerful digital computer being capable of overwhelming problems with little or no finesse.

So as not to be accused of funnel vision, I offer some comments on the affirmative side of this condition. Most mathematical techniques were evolved for the solution of the equations of motion of simple systems with conveniently expressed geometry and forces. This left an obvious gap between the academic conception and the engineering solution that was filled by a man who sat before a desk calculator and used simple numerical techniques. So, in fact, the digital computer merely automated existing numerical methods and reduced the time and cost for calculation. However, in this process many more complicated problems were solved because of larger model sizes. When the power of the simple numerical methods was expended, the more efficient finite element models were developed to solve larger problems.

This all leads to the fact that without the aid of the digital computer many of the shock and vibration problems of the last 10 yr would not have been solved in the economically most advantageous stage, namely the design stage. In addition, the computation of natural frequencies and response of large structures and machines through the use of multidegree-of-freedom models yields a far superior product at the prototype stage. The determination of the response of beams, rotors, panels, and structures to shock and vibration environments is now state-of-the-art. In fact there are many computer codes available today for use in the solution of such problems. These codes, available for a user fee or for sale, provide a powerful design tool for a small investment.

Therefore, from an engineering point of view the computer has been good news because it has increased our capability for problem solution by several orders of magnitude; it has reduced the cost, when used effectively, in the development of systems; and it has provided a diagnostic tool for system troubles whether they exist in a developmental system or in an existing system.

R. E.

International Design Automation Conference
8-10 Sept. 1971
Toronto, Canada

This was the first such theme conference held under ASME auspices; it was an ambitious and worthwhile undertaking. Credit is due the organizer, Professor Ali Siereg (University of Wisconsin) and one looks forward to a continuation of such conferences.

The collection of papers (34, of which not all were presented) was generally interesting though, by body count, attendance was poor. The papers including six tutorials dealt, according to the program, "...with the general problems of utilizing computer technology in automating the design process and optimizing mechanical design." The extent to which these goals were realized, or even approached, depends on one's view of design and the associated meaning of automation. In this reporter's opinion, no serious attempt was made to formulate (or even address implications of) the algorithmic view of design implicit in the conference theme. Indeed, to those who hold the opposite view, the conference probably achieved no conversions. To the extent that more than semantics is involved (e.g., computer-aided design vs automated design), discussion of the role of, and potential for, automation in the process of design was conspicuously lacking at the conference. (This includes an otherwise successful informal gathering of the interested on the second night of the conference; an excellent idea by Professor Seireg.)

None of the foregoing should cast aspersion on the worth of many of the papers, and those interested in the bits and pieces of what computer-oriented people are doing these days (and some perhaps calling "automated design") can find much to occupy themselves.*

*Though all papers appeared as ASME preprints, it is not clear that all will subsequently be published in a Division Journal or the Transactions.

Some half of the papers dealt with a particular application computer analysis, either as an end in itself or in support of a larger undertaking. Nearly half of these, in turn, concerned an optimization problem. Of interest in the five, of six, sessions attended by this reporter, were papers on the synthesis of control prosthetics (bioengineering applications by M. Townsend, and A. Seireg, "A Mathematical Programing Method for Trajectory Synthesis of Coupled Rigid Bodies"); the synthesis of linkage systems (M. Tranquilla, 'Cptimum Design of Four-Bar Linkage Whose Coupler Path Has Specified Extremes"); and an analysis of articulated vehicles (A.I. Krauter and D.L. Bartel, "An Automated Method for Evaluating Truck Design").

The general survey papers by R. E. Fulton of NASA-Langley (mostly aerospace structural applications) and A. Seireg offered an excellent overview, including extensive bibliographies, of the sorts of problems being approached by systematic computational means.

The second largest group of papers (the other half) were methodology-oriented, though often with specific application. The tutorial lecture by O. Managasarian on "Techniques of Optimization" was excellent and the paper itself should serve many as a useful summary of computational optimization algorithms. Emphasis was mostly on methods requiring derivative evaluation (analytically or otherwise), little being said about direct search methods; but you can't have everything. A most interesting paper dealt with nonlinear integer programing techniques (application to ship structural design by Johannes Moe and Kaare M. Gisvold, "A Method for Nonlinear Mixed Integer Programing and Its Application to Design"). An interesting aspect of this paper was the realization of how relatively advanced the Norwegian ship building industry is in availing themselves of modern design methods. Another paper of interest (M. Adamowicz, "Optimum Allocations of Two-Dimensional Shapes") seems a worthwhile contribution to the literature on pattern layout and minimum material usage (application in the paper was to pattern problems of the garment industry which is indicative of the complexity of geometric shapes considered).

Several interesting papers were concerned with analysis and synthesis of mechanisms. P. Sheth and J. Uicker, Jr. ("Integrated Mechanisms Program") presented a general purpose, problem-oriented language for the analysis of a large class of three-dimensional mechanisms. Closely related in concept, though limited to planar mechanisms, was the paper by R. C. Dix and T. J. Lehman, "Simulation of the Dynamics of Machinery." Mechanism synthesis techniques were explored in the previously mentioned paper by Tranquilla and in the paper by J. C. Cropper, "Synthesizing a Tractor Steering Linkage to Generate a Desired Turning Function." Only two papers dealt directly with system or design parameter identification (J. R. Baumgarten and J. W. Kitchen, "Use of Optimization Techniques in Identifying a Shock Absorber", and E. Sevin, "Automated Design Parameter Identification").

Eugene Sevin
University of the Negev
Beer-Sheva, Israel

SPECTRUM

SPECTRUM is intended as a column for the expression of readership opinion and will appear as comment is available. It is hoped that it will provide a ground for intelligent controversy on subjects of concern to the shock and vibration community.

Letter to the Editors:

I have just read your editorial in the August 71 issue of the DIGEST (Vol. 3 No. 8).

You have struck at the core of a great problem. You have given a very capable application of the old cliche "figures don't lie but liars figure." This has long been a way of life for me in critiquing my own work. Maybe that is why I do so little writing. I really don't know that I have a lot to contribute other than some homespun philosophy.

G. Dean McAdoo
President
Noise Unlimited, Inc.
130 Center St.
Somerville, N. J.

DECEMBER

COMPUTER IMPLEMENTATION OF NUMERICAL ANALYSIS FOR THE SOLUTION OF ENGINEERING PROBLEMS
Place: Camden, N.J.
Dates: Dec.
Objective: Methods for implementing solution of math expressions with the computer will be covered. Algorithms, Fortran programs, and error analyses are included.

Contact: RCA, Director of Professional Educational Services, Camden, N.J. 08102

JANUARY

VIBRATION AND SHOCK TESTING
Place: Washington, D.C.
Dates: Jan. 10-14
Objective: Refer to Vol. 3 Issue 3 of the DIGEST.

Contact: Tustin Inst. Tech., Inc., 22 E. Olivos St., Santa Barbara, Calif. 93105

FIXTURE DESIGN COURSE TO BE GIVEN
Place: Los Angeles, Calif.
Dates: Jan. 24-28
Objective: The course is intended for specialists who design fixtures used to attach test items to shakers and to shock test machines for environmental testing. Main emphasis is on simplified techniques for analyzing test items, on analyzing tentative fixture designs in order to select the best design, on least expensive fabrication methods and on experimental evaluation of completed fixtures. Test lab personnel who use fixtures will also benefit from this course, as will Quality, Reliability and Evaluation personnel who specify vibration and shock tests.

Contact: Tustin Inst. Tech., Inc., 22 E. Los Olivos St., Santa Barbara, Calif. 93105

MEASUREMENT SYSTEMS ENGINEERING
Place: Ariz. State Univ.
Dates: Jan. 24-28
Objective: An approach to measurement system design will be offered which subjects the entire process of system design, specification, performance and evaluation to critical study. Laws which are specific to the field of measurement engineering will be formulated and it will be shown how valid, noise-free data can be obtained by design.

Contact: P. K. Stein, Engr. Ctr., Ariz. State Univ., Tempe, Ariz. 85281

DIRECT ENERGY CONVERSION
Place: Ariz. State Univ.
Dates: Jan. 24-28
Objective: This course will cover the physical principles underlying all of the conversion devices and present a unified theory of energy converters which enables them to be classified and compared. The current status and applications in the various area of Direct Energy Conversion will be presented by top technical men in their respective fields.

Contact: C.E. Backus, Engr. Ctr., Ariz. State Univ., Tempe, Ariz. 85281

DESIGN FOR VIBRATION AND SHOCK ENVIRONMENTS
Plate: Los Angeles, Calif.
Dates: Jan.
Objective: Ways to reduce the present high costs and long delays of vibration and shock weaknesses of industrial and consumer products, weapons, shipping containers, etc., will be given. Many of these can be avoided if weaknesses are detected during the initial design stage. The course is intended to give mechanical designers the ability to detect such weaknesses and to correct their designs.

Contact: Tustin Inst. Tech., Inc., 22 E. Los Olivos St., Santa Barbara, Calif. 93105

ABSTRACTS FROM THE CURRENT LITERATURE

Note: Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers. Reports may be ordered from the National Technical Information Service, Operations Division, Springfield, Virginia 22151.

ANALYSIS AND DESIGN METHODS

ANALYTICAL METHODS

71-1419

MODAL SUBSPACES AND NORMAL MODE VIBRATIONS
Greenberg, H.J. and Yang, T.L.
Intl. J. Nonlinear Mech. 6 (3), 311-326 (June 1971)

Key Words: nonlinear systems

Trajectories of nonlinear conservative systems having n degrees-of-freedom can be identified with the motions of a unit mass in an n-dimensional Euclidean space under a force derivable from a potential function. Special classes of motions of the system are dealt with for which the trajectories of the unit mass remain in subspaces of the Euclidean n-space; these are called modal subspaces.

71-1420

VIBRATION RESPONSE AND WAVE PROPAGATION IN PERIODIC STRUCTURES
Mead, D.J.
J. Engr. Industry Trans. ASME 93 (3), 783-792 (Aug. 1971)

Key Words: beams, vibration response, wave propagation

The vibration response of periodic beamlike structures has been studied by both transfer matrix or normal mode methods. Both have shortcomings. A method is described which permits a ready formulation of the response-calculation problem for a special class of flexural wave groups which can exist in periodic structures. The formulation can be applied to both infinite and finite structures, and the amount of damping present may have any value. The method is especially well adapted to studying response resulting from convected pressure fields and loadings and gives great physical insight.

71-1421

MODAL REPRESENTATIONS FOR THE HIGH FREQUENCY RESPONSE OF ELASTIC PLATES
Randles, P.W. and Miklowitz, J.
Intl. J. Solids Structures 7 (8), 1031-1055 (Aug. 1971)

Key Words: dynamic response, high frequency excitation, plates

High frequency representations for the response of an infinite plate to an impulsive line load are extracted from a new form of the usual modal solution. A change of variables is used to facilitate an investigation of the branches of the Rayleigh-Lamb frequency equation. Points of the branches are found about which analytic continuations are made, which lead to the new form of the modal solution and which uncouple the dilatational and equivoluminal motion. Singular wave fronts are investigated and certain terms in the final solution, approximated with high-frequency series representations for the branches, are evaluated and compared with known half-space solutions. The method is applicable to certain anisotropic materials; however, a homogeneous, isotropic plate is treated.

INTEGRAL TRANSFORMS

71-1422
TIMOSHENKO BEAM DYNAMICS
Anderson, G.M.
J. Appl. Mech. Trans. ASME 38 (3), 591-594 (Sept. 1971)

Key Words: beams, dynamic analysis, Laplace transforms, Timoshenko theory

The Laplace transform method is used to solve the general problem of Timoshenko beam analysis. Time-dependent boundary and normal loads are considered and it is established that the integrands of the inversion integrals are always single valued for beams of finite length. In addition, modal solutions can always be obtained using the residue theorem.

71-1423
THE RADIATION IMPEDANCE OF A BAFFLED PISTON SOURCE
Hamson, R.M.
J. Sound and Vibration 17 (3), 397-406 (Aug. 8, 1971)

Key Words: disks, plates, sound waves, vibrating structures

The problem of a vibrating disk set in a finite, rigid, concentric baffle is reduced to the solution of a Fredholm integral equation of the second kind. The acoustic radiation impedance is computed from the numerical solution of this equation and results tabulated for values of between 0.2 and 2.0 (wavenumber x disk radius).

STATISTICAL METHODS
(Also see Nos. 1495, 1503)

71-1424
RANDOM SPECTRUM AND STRUCTURAL PROBABILITY OF FAILURE
Wang, A.P.
J. Sound and Vibration 17 (3), 357-362 (Aug. 8, 1971)

Key Words: aircraft, random excitation, structural response

The structural probability of failure due to combined load spectra is considered. Two types of probability of failure are presented after a short review on the effect of random loads compared with sinusoidal loads. The first deals with the case in which the probability of failure is proportional to the sum of the loads. The second covers the probability of failure proportional to the root mean square of the loads.

VARIATIONAL METHODS

71-1425
FREE VIBRATIONS OF A LINEAR STRUCTURE WITH ARBITRARY SUPPORT CONDITIONS
Dowell, E.H.
J. Appl. Mech. Trans. ASME 38 (3), 595-600 (Sept. 1971)

Key Words: free vibration, Rayleigh-Ritz method

A method is presented for the analysis of the free vibrations of a linear structure supported in an arbitrary way. The method is based upon the use of the normal modes of the unsupported or unconstrained structure in a Rayleigh-Ritz analysis with the support or constraint conditions enforced by means of Lagrange multipliers The advantages of more conventional methods are discussed.

NONLINEAR ANALYSIS
(Also see Nos. 1419, 1484)

71-1426
NONLINEAR OSCILLATIONS OF A THIRD-ORDER DIFFERENTIAL EQUATION
Mulholland, R.J.
Intl. J. Nonlinear Mech. 6 (3), 279-294 (June 1971)

Key Words: nonlinear systems

An investigation of the behavior of the solutions of a third-order nonlinear differential equation which is characterized by a nonlinearity depending solely upon the Euclidean norm of the associated phase space is reported. The nonlinearity represents a central restoring force, which has important applications in modern control theory For small nonlinearities, the existence of a limit cycle is established by a fixed point technique, the approach to the limit cycle is approximated by averaging methods, and the periodic solution is harmonically represented by perturbation. Computer solutions of the differential equation are provided in order to reinforce the analysis. Some related differential equations are discussed including one in which the periodic solution is explicitly prescribed.

NUMERICAL ANALYSIS

(Also see Nos. 1470, 1480, 1482)

STABILITY ANALYSIS

(Also see Nos. 1468, 1499)

71-1427

OPTIMIZATION OF COMPLEX STRUCTURES TO SATISFY FLUTTER REQUIREMENTS
Rudisill, C.S. and Bhatia, K.G.
AIAA J. 9(8), 1487-1491 (Aug. 1971)

Key Words: aircraft, flutter, optimization

Equations for finding the partial derivatives of the flutter velocity of an aircraft structure with respect to structural parameters are derived. A numerical procedure is developed for determining the values of the structural parameters such that a specified flutter velocity constraint is satisfied and the structural mass is a relative minimum. A search procedure is presented which utilizes two gradient search methods and a gradient projection method. The procedure is applied to the design of a box beam.

MODELING

(Also see Nos. 1476, 1489, 1501, 1517, 1521, 1531)

71-1428

THEORY OF INCOMPLETE MODELS OF DYNAMIC STRUCTURES
Berman, A. and Flannelly, W.G.
AIAA J. 9(8), 1481-1486 (Aug. 1971); see also NASA-CR-109630, 138 pp (1971)

Key Words: mathematical models, parameter identification

A method is presented for identifying parameters in a linear, discrete model of a structure. Measured normal modes are used to modify an analytically derived model. The structure has a large number of points of interest and a frequency range influenced by a relatively small number of normal modes. The analytical model has fewer degrees of freedom (normal modes) than coordinates (points of interest). The characteristics of this model and methods of using it are discussed. Computer experiments illustrate these methods.

71-1429

DEFORMATION OF PRESTRESSED THIN SHELLS
Kalnins, A. and Biricikoglu, V.
Nuclear Engr. Design 16(3), 343-357 (July 1971)

Key Words: free vibration, shells, stability

Starting from the equations of a three dimensional medium, the authors derive the governing equations for a thin shell for infinitesimal, elastic deformations, superimposed upon a prestressed state. No further approximations are made except those of the Kirchhoff hypothesis of shell theory. The equations are referred to the prestressed state for which geometry, initial stress, and material properties are assumed to be known. The final equations are listed in terms of the physical components of all variables and are referred to the lines of curvature of the reference surface of the shell in the prestressed state. They can be used directly for such problems as the stability or free vibration of initially stressed shells.

71-1430

MIDDLE EAR FUNCTION: A KINEMATIC ANALYSIS
Marples, V.
Acustica 24(6), 347-353 (June 1971)

Key Words: acoustic excitation, biomechanics, ear, kinematics, mathematical models

The mode of transmission of energy through the middle ear is well understood qualitatively. There are many quanitative facets which remain undocumented. Mathematical simulation is used to achieve this end. The middle ear mechanism is subjected to topological analysis and an investigation of the number of degrees of freedom. These are interpreted in the light of current knowledge on the mode of operation. Alternative suggestions relating to details of the modes of motion of the ossicles result. Evaluation of these awaits more precise data on the relative elasticities of joints, ligaments etc. A detailed dimensional geometrical model of the middle ear is recommended for further work.

71-1431

FINITE ELEMENT FOR TIMOSHENKO BEAM BASED ON MECHANICAL IMPEDANCE
Rangaiah, V.P. and Neubert, V.H.
Pa. State Univ., 133 pp (Apr. 1971)

Key Words: beams, finite element technique, mechanical impedance, Timoshenko theory

71-1435

THE ATTENUATION OF UNDERWATER SOUND: A REVIEW OF EXPERIMENTAL AND THEORETICAL INVESTIGATIONS
Lauer, R.B.
Naval Underwater Systems Ctr., 36 pp (Nov. 2, 1970)

Key Words: noise reduction, underwater sound

Experimental and theoretical investigations of the attenuation of underwater sound are reviewed. The known or postulated primary mechanisms of attenuation, namely viscosity, magnesium sulfate relaxation, and the structural relaxation of water molecules, are discussed. Empirical and theoretical expressions for the attenuation coefficient in sea water are given in terms of the frequency and the environmental parameters of temperature and pressure.
AD-718330

71-1436

A NOTE ON SOUND RADIATION FROM A SUBSONICALLY ROTATING SOURCE PATTERN
Morfey, C.L.
J. Sound and Vibration 17(3), 331-334 (Aug. 8, 1971)

Key Words: annular disks, sound radiation

The farfield pressure and radiation efficiency are approximated analytically for an annular-disk source, with uniform amplitude circumferentially over the disk and linear phase variation. The results are significantly different from those obtained by neglecting the annulus width and concentrating the source at the outer radius. Most of the radiated power is accounted for by the annulus mode component of lowest radial order. An incidental result is a rough analytical approximation to the Bessel function integral for values of the argument less than the mentioned order.

71-1437

FREQUENCY-AVERAGED POWER FLOW INTO A ONE-DIMENSIONAL ACOUSTIC SYSTEM
Scharton, T.D.
J. Acoust. Soc. Am. 50(1), 373-381 (July 1971)

Key Words: acoustic response, impedance, statistical energy methods

This work shows the effect of the drive-point impedance of a finite acoustic system on the power delivered by a realistic source. At low frequencies when the modal overlap of the system is small, the frequency-averaged power delivered by the source can be much less than the power which the source would deliver to an equivalent semi-infinite system. An analysis of the power flow into a finite one-dimensional wave tube is used to explain the observation that broadband high-intensity acoustic drivers deliver less low frequency power to small reverberation chambers than they deliver to progressive wave tubes. The analysis indicates that the modal overlap also plays a central role in the determination of the ratio of space averaged to drive-point response.

71-1438

SUBHARMONIC GENERATION IN ACOUSTIC SYSTEMS
Yen, N.C.
Harvard Univ., 38 pp (May 1971)

Key Words: mathematical models, underwater sound

The report is concerned with the theoretical and experimental study of subharmonic generation in acoustic systems. The generalized formulation for lumped systems is considered for the case of three oscillators coupled through a nonlinear element. The resulting analysis indicates that the high frequency oscillation is unstable and its energy can be diverted to low frequency oscillations; that is, subharmonics are generated.
AD-725604

A finite element model for representation of a Timoshenko beam segment is derived. The model is a massless beam having bending and shear flexibility and carrying concentrated masses on rigid arms to account for translatory and rotary inertia. The accuracy of the model is demonstrated by comparing its impedance and ground shock response to those of the exact Timoshenko beam, the exact Bernoulli-Euler beam, and center-of-gravity lumped mass models.
AD-724332

DIGITAL SIMULATION
(Also see Nos. 1485, 1501)

DESIGN INFORMATION
(Also see Nos. 1479, 1525, 1530, 1536)

DESIGN TECHNIQUES
(Also see Nos. 1461, 1520)

71-1432
SLED DESIGN TECHNIQUES
Mixon, L. C.
Holloman AFB, 469 pp (Feb. 1971)

Key Words: dynamic pressure excitation, mathematical models, rocket sleds

The motion of a sled on the track induces large quasi-steady state and dynamic forces on the sled. The design of sleds requires knowledge of these forces and of established techniques for the application of measured and theoretical forcing functions to proved mathematical structural simulations. Multicomponent force transducers developed as an integral part of a sled structure are described. An extensive measurements program conducted on the high-speed test track using these transducers is reported. Rocket sled motion is simulated by a nonlinear rigid body computer model with provisions for adding secondary mass systems. Random analysis techniques are applied to the sled linear computer models. These techniques are organized into recommended design procedures for rocket sleds.
AD-719751

STANDARDS AND SPECIFICATIONS
(Also see No. 1450)

SURVEYS
(Also see Nos. 1435, 1511, 1536)

71-1433
A LITERATURE SURVEY OF NOISE POLLUTION
Shih, H. H.
Catholic Univ. Am., 96 pp (Mar. 1971)

Key Words: aircraft noise, human factors engineering, noise, reviews

The problem of noise is studied. The survey consists of four major parts: the present status of noise pollution, sources, effects, and controls. Many urgent research needs are identified. Lists of terminology and bibliography relating to noise pollution problems are provided.
AD-724344

EXCITATION

ACOUSTIC
(Also see Nos. 1446, 1449, 1456, 1458, 1495, 1502, 1503, 1509, 1516, 1525, 1526)

71-1434
ACOUSTIC RADIATION FROM VIBRATING PROLATE SPHEROIDS
Lauchle, G. C.
Pa. State Univ., 83 pp (June 3, 1970)

Key Words: acoustic radiation, submerged structures, underwater sound

Prolate spheroidal coordinates and associated prolate spheroidal wave functions as used to determine the acoustic radiation from prolate spheroids whose surfaces vibrate arbitrarily are studied. The theory is general enough to include a wide range of specific acoustic problems such as radiation from nonspherical sources (cylinders with end caps, disks, etc.) and acoustic scattering.
AD-720714

RANDOM
(Also see No. 1452)

SHOCK
(Also see Nos. 1432, 1440, 1516, 1533)

PHENOMENOLOGY

ELASTIC
(Also see No. 1460)

71-1439
THE DIFFRACTION OF ELASTIC WAVES AND DYNAMIC STRESS CONCENTRATIONS
Mow, C. C. and Pao, Y. H.
Rand Corp., 694 pp (Apr. 1971)

Key Words: hardened structures, nuclear explosions, underground structures

Methods for analyzing both steady and transient stress loadings on diverse objects under various circumstances, and specific numerical findings for dynamic stress concentrations on objects of different shapes are presented. The scattering of elastic (stress) waves is clearly shown to be no different from the scattering of sound or electromagnetic waves. Much of the analysis is based on wave propagation methods.
AD-724893

INELASTIC
(Also see No. 1471)

VISCOELASTIC
(Also see Nos. 1478, 1488, 1517)

71-1440
CRITICAL INDUCED ACCELERATION FOR SHOCK PROPAGATION IN POLYMETHYL METHACRYLATE
Schuler, K. W. and Walsh, E. K.
J. Appl. Mech., Trans. ASME 38 (3), 641-645 (Sept. 1971)

Key Words: shock waves, viscoelastic materials

Whether a shock wave in a nonlinear viscoelastic material will grow, decay, or remain steady is directly related to whether the acceleration just behind the wave is greater than, less than, or equal to a certain critical acceleration. The experimental results of Schuler and Barker are used in this study to determine this critical induced acceleration as a function of the strain behind the shock for polymethyl methacrylate.

COMPOSITE
(Also see No. 1491)

DAMPING
(Also see Nos. 1497, 1528)

71-1441
ENERGY FLUX IN DUCT FLOW
Möhring, W.
J. Sound and Vibration 18 (1), 101-109 (Sept. 8, 1971)

Key Words: ducts, sound waves

An energy equation for the linearized gas dynamic equations is derived. This conservation equation is applied to the problem of sound propagation in a sheared fluid contained in a duct. It is shown that for soft and hard walls the total energy flux through the duct equals the sum of the energy fluxes of the propagating modes. An example is considered.

FLUID
(Also see No. 1508)

71-1442
ANALYSIS OF MULTIMODE ACOUSTIC PROPAGATION IN LIQUID CYLINDERS WITH REALISTIC BOUNDARY CONDITIONS -- APPLICATION TO SOUND SPEED AND ABSORPTION MEASUREMENTS
Del Grosso, V.A.
Acustica 24 (6), 299-311 (June 1971)

Key Words: cylindrical shells, fluid filled containers, fluids, sound waves

Multimode axial acoustic propagation within inviscid liquid cylinders is considered by exact formulation of the boundary conditions for a radially surrounding finite impedance elastic solid of finite wall thickness. The modes are utilized in describing both interferometer and nonterminated or pulsing situations. The formulation indicates that a judicious selection of

the experimental configuration can limit diffraction propagation uncertainties to a few parts per million.

71-1443

THE OSCILLATIONS OF A SPHERE IN A MICROPOLAR FLUID
Rao, S.K.L. and Rao, P.B.
Intl. J. Engr. Sci. 9(7), 651-672 (July 1971)

Key Words: micropolar fluid, sphere

The rectilinear oscillation of a sphere along a diameter and the rotary oscillation of a sphere about a diameter in Eringen's micropolar fluid are examined. The physical quantities like the velocity, microrotation and the stress and couple stress components are calculated. The drag on the rectilinearly oscillating sphere and the couple on the rotational oscillating sphere are calculated. It is observed that over any period of oscillation, the maximum drag or the maximum couple, as the case may be, is larger in the case of micropolar fluids as compared to the Newtonian fluid.

71-1444

THE NATURAL FREQUENCY OF A SPHERICAL BUBBLE IN THE VICINITY OF A SOLID WALL
Shima, A.
Calif. Inst. Tech., 20 pp (July 1970)

Key Words: bubble dynamics, natural frequency

The natural frequency of a spherical bubble in a liquid as it oscillates in the vicinity of a solid wall is theoretically studied in terms of the effect of surface tension. It is assumed that the gas in the bubble follows the law of adiabatic change. Further, the effects of a solid wall and the kind of liquid on the natural frequency of the bubble are numerically clarified.
AD-724755

71-1445

THE NATURAL FREQUENCIES OF THREE SPHERICAL BUBBLES OSCILLATING IN WATER
Shima, A.
Calif. Inst. Tech., 25 pp (July 1970)

Key Words: bubble dynamics, natural frequency

The natural frequencies of three spherical bubbles, as they oscillate near each other in water, are studied. Surface tension is accounted for and it is assumed that the gas in the bubble follows the law of adiabatic change.
AD-724759

71-1446

MODE COLORATION IN SHALLOW-WATER AMBIENT NOISE
Weston, D.E.
Admiralty Res. Lab. (England), 23 pp (June 1970)

Key Words: underwater sound

The spectrum of ambient noise observed in the shallow waters of the Bristol Channel shows a series of characteristic peaks. Up to six peaks are seen, the frequency of each varies inversely with the water depth as the latter changes through the tidal cycle. Each peak corresponds to the cutoff frequency of one of the normal modes of sound propagation, since at this frequency there are ideally no losses caused by coupling into either longitudinal or shear waves in the rock bottom.
AD-720591

SOIL

(Also see No. 1515)

71-1447

DETERMINATION OF THE ACOUSTIC PROPERTIES OF FROZEN SOILS
Nakano, Y.; Smith, M. Jr.; Martin, R.; Stevens, H.W.; and Knuth, K.V.
Cold Regions Res. Engr. Lab., 73 pp (May 1971)

Key Words: acoustic properties, frozen soils, soils

The acoustic properties of frozen earth materials are investigated. The study consists of four different efforts: (1) the velocities of dilatational waves are measured with the pulse first-arrival technique; (2) a linear viscoelastic constitutive equation is obtained by the use of the resonance column technique; (3) the method of free oscillation of spherical specimens is developed; and (4) the acoustic properties are determined by the use of a critical angle tank.
AD-724122

71-1448

VOLUME CHANGES IN SANDS DURING CYCLIC LOADING
Silver, M.L. and Seed, H.B.
J. Soil Mech. Foundations Div., Proc. ASCE 97 (SM9), 1171-1182 (Sept. 1971)

Key Words: sand, seismic response, soils, test data, vibratory compacting

Measurements of the volume change behavior of sands under cyclic loading simple shear conditions suggest that the vertical strain resulting

from compaction depends only on the shear strain amplitude induced in the sample at strains exceeding 0.05 percent. This indicates that cyclic shear strain, which deforms the sample allowing particles to move into denser packing, may well be a fundamental parameter in determining the volume change behavior of cohesionless soils under dynamic loading conditions. The test data may be used to evaluate the possible magnitude of ground surface settlements owing to ground shaking caused by earthquakes or other types of ground vibrations.

EXPERIMENTATION

DIAGNOSTICS

(Also see No. 1458)

71-1449

ACOUSTIC-EMISSION TESTS REVEAL CRITICAL VESSEL FLAWS
Ewing, R. C.
Oil and Gas J. 69 (37), 90-93 (Sept. 13, 1971)

Key Words: acoustic tests, pressure vessel

Acoustic-emission tests of heavy-wall pressure vessels are proving effective in finding weld defects and other defects in the structure. These tests which can locate critical flaws that could grow under stress and result in catastrophic failure are discussed.

EQUIPMENT

(Also see Nos. 1457, 1458)

71-1450

INSTRUMENTATION FOR MONITORING
Blake, M. P.
Power Transmission Design 14 (9), p 85 (1971)

Key Words: vibration monitoring

The vibration of machines is described and some typical machine vibration levels are given.

71-1451

ACOUSTIC EMISSION TEST FACILITY
James, D. R. and Carpenter, S. H.
Rev. Sci. Instrum. 42 (8), 1131-1136 (Aug. 1971)

Key Words: acoustic tests, test facilities

An acoustic emission test facility constructed to allow constant strain rate compressive deformation of samples up to an applied load of 1800 kg is described. Strain rates of from 1.6×10^{-3} to 3.2×10^{-6} sec^{-1} are obtained with total system noise limited to less than 10 μV peak-to-peak referred to the input of the preamplifier. Overall signal amplification is 9900 ± 100 over a bandwidth of 200 Hz - 200 kHz.

71-1452

RANDOM VIBRATION EQUALIZATION
Kana, D. D. and Scheidt, D. C.
Instruments and Control Systems 44 (8), 87-89 (Aug. 1971)

Key Words: random vibration, test equipment

This article describes the equipment and technique necessary for random vibration equalization of arbitrary specimens.

71-1453

THE SKIDDING OF VEHICLES, A DYNAMIC ANALYSIS -- REPORT NO. 4: A DYNAMICAL ANALYSIS OF A TOWED TWO-WHEEL TRAILER
Saibel, E.A. and Chiang, S. L.
Carnegie-Mellon Univ., 27 pp (Mar. 1971)

Key Words: dynamic analysis, mathematical models, trailers

The towed trailer method for skid resistance measurements is a practical one for determining the friction characteristics of highway pavements, and has been standardized by the ASTM. This paper presents a mathematical model of the trailer which includes roll, pitch, and vertical motion. The skid resistance calculated by using this model gives an excellent check on the standard ASTM skid number formula. The response time and damping effect after locking one test wheel can be clearly seen in this model. Possible effects of the dimensions of trailer, stiffness of suspension system, tire pressure, etc., to skid resistance can also be examined.
PB-199094

71-1454

PERFORMANCE OF ULTRASONIC EQUIPMENT FOR PAVEMENT THICKNESS MEASUREMENT AND OTHER HIGHWAY APPLICATIONS
Scholer, C. F.
Purdue Univ., 39 pp (July 16, 1970)

Key Words: measuring instruments, pavement thickness, ultrasonic tests

A soniscope and an associated frequency generator and counter for determining resonant frequency through the depth of the pavement slab are used and found to be unsatisfactory for measuring pavement thickness. The equipment is useful in determining the continuity of concrete in a structure such as in a survey of a bridgedeck to determine areas with deteriorated concrete or incipient spalling.
PB-200151

EXPERIMENT DESIGN

(Also see No. 1534)

INSTRUMENTATION

71-1455

HYDROACOUSTIC IMAGE TRANSDUCER
Knollman, G. C. and Brown, A. E.
Rev. Sci. Instrum. 42 (8), 1202-1214
(Aug. 1971)

Key Words: acoustic detectors, measuring instruments, transducers

A solid state, linear array piezoelectric acoustic image converter is described which has been developed for real time underwater viewing, especially in turbid and/or turbulent oceanic environments. Sensitivity and resolution of the acoustoelectric transducer are on the order of 10^{-11} W/cm^2 and 1 mm, respectively, at a frequency of 2.5 MHz. Imaging range up to 10 m is possible in turbidity concentrations of suspended ocean sediment (average particle diameter from 1 to 10 μ) of several thousand parts per million. Expected ranges are at least five times larger in clear water. Fabrication and performance of the transducer array are discussed. Image scanning mirror, internal and external electronic circuitry, and the image display, all associated with the hydroacoustic converter, are also delineated.

71-1456

INDUSTRIAL NOISE AND COUNTERMEASURES -- CHAPTER V: NOISE RESEARCH METHODS AND MEASURING DEVICES
Slavin, I. I.
Brooks AFB, 42 pp (1971)

Key Words: measuring instruments, noise measurement

Subjective and objective methods and devices for the measurement of sound are discussed. Topics included are: the sound level meter, frequency analyzer, band analysis of noise, noise spectrums, and noise registration.
AD-720414

TECHNIQUES

(Also see Nos. 1446, 1449, 1452)

71-1457

A MEMBRANE ANALOGY TO AN ACOUSTIC DUCT
Hine, M. J. and Fahy, F. J.
J. Sound and Vibration 18 (1), 1-7
(Sept. 8, 1971)

Key Words: acoustic linings, ducts

Despite its theoretical limitations, a circular membrane is used experimentally as an analog to a cylindrical acoustic waveguide. The analog successfully predicts normal mode behavior for a cylindrical-annulus waveguide with eccentric boundaries, and the effects of adding further cylindrical boundaries within an existing cylindrical annulus waveguide. In both cases the modal cutoff frequencies are found to be unchanged, and the expected angular "locking" of nodal diameters found to be absent.

71-1458

ACOUSTIC HOLOGRAPHY: A NEW DIMENSION IN SEEING WITH SOUND
Lavoie, F. J.
Mach. Design 43 (21), 70-75 (Sept. 2, 1971)

Key Words: acoustic holography, acoustic tests, testing techniques

The advantages of using sound to look into optically opaque objects are well established; but conventional acoustic imaging techniques are only two-dimensional. Acoustic holography adds a third dimension. Promising applications include nondestructive testing, underwater and underground viewing, and medical diagnostics.

71-1459

THE SNOWMOBILE SUSPENSION -- A HIGH-SPEED MOTION PICTURE STUDY
Newman, J. A. and Beale, D. J.
SAE Preprint 710667

Key Words: snowmobiles

An examination is made via high-speed motion picture photography, of the behavior of a typical snowmobile suspension system. This work is

primarily diagnostic in nature, in that the emphasis is on examining the conditions responsible for certain vehicle performance patterns. Several preliminary recommendations for improving the suspension are made.

71-1460

SOUND SPEED MEASUREMENTS IN SOLIDS: ABSOLUTE ACCURACY OF AN IMPROVED TRANSIENT PULSE METHOD
Proctor, T.M., Jr.
J. Res. Natl. Bur. Standards 75C(1), 33-40 (Jan./Mar. 1971)

Key Words: measurement techniques, sound waves, wave propagation

A modified transient pulse technique for measuring shear and longitudinal sound speeds in solids is presented. The technique is described and evaluated for both precision and accuracy on a variety of solids. This evaluation is done by experiments in which the constancy of sound speed with path length is used as the prime test for accuracy.

COMPONENTS

ABSORBERS

71-1461

TIME DOMAIN OPTIMIZATION OF A VIBRATION ABSORBER
Bartel, D.L. and Krauter, A.I.
J. Engr. Industry, Trans. ASME 93(3), 799-804 (Aug. 1971)

Key Words: transient response, vibration absorbers

Two design problems involving the transient vibrations of a dynamic vibration absorber are considered. In the first problem, the maximum force transmitted between masses in an absorber system is minimized. In the second, the time required for energy dissipation is minimized. A method of constrained steepest descent is used with state equations to obtain solutions.

71-1462

SHOCK ABSORBER
Furminieux, G. and Pflugrad, K.
Natl. Sci. Abstracts (Dec. 31, 1970)

Key Words: shock absorbers

A shock absorber is presented for braking and stopping a rapidly falling emergency shutdown rod. It consists of tubular elements in a multilayered arrangement which maintain by themselves the distance between the disks separating two adjacent layers. The elements consist of cylindrical tubes made of inelastic materials radially arranged around an axis of symmetry perpendicular to the disks. (In French)
French Patent 2,036,729

71-1463

ENERGY-ABSORBING BRIDGE RAIL (FRAGMENTING TUBE)
Hirsch, T.J.; Stocker, A.J.; and Ivey, D.L.
Tex. Transportation Inst., 39 pp (Feb. 1970)

Key Words: energy absorption, guardrails

A series of four vehicle crash tests conducted to evaluate an energy-absorbing bridge rail is reported.
PB-199420

71-1464

THE MENASCO ENERGY ABSORBING UNIT AND ITS APPLICATION TO BUMPER SYSTEMS
Kendall, G.A.
SAE Preprint 710536

Key Words: automobiles, shock absorbers

The Menasco energy absorbing (E/A) unit and its application to automotive vehicle E/A bumper systems are described. Areas covered include: E/A unit and shock isolator configurations; performance characteristics; reliability; and probability. Also included are possible bumper system configurations, system structural design criteria, and vehicle testing.

71-1465

LANDING IMPACT PROTECTION THROUGH A HYBRID ATTENUATION SYSTEM
Merz, E.J.; Burnes, J.A.; and McClure, S.R.
J. Spacecraft 8(8), 879-885 (Aug. 1971)

Key Words: air cushion landing systems, energy absorption, landing impact

A program to determine the most advantageous method of attenuating the landing shock of an unmanned system at terminal velocity of 20-200 fps with limited attitude control is reported. A hybrid pneumatic configuration resulted which has a hard-surfaced footpad on which a dual pneumatic bag attenuator is attached to support a payload cylinder.

71-1466
PERFORMANCE OF A VISCOUS-FRICTION TORSIONAL-VIBRATION DAMPER
Pervyshin, V.G. and Naumov, P.I.
Russian Engr. J. L (11), 19-23 (1970)

Key Words: absorbers, torsional response

Parameters characterizing the performance of a silicone-fluid torsional vibration damper, and their influence on energy storage are considered. Recommendations are made about the selection of damper design parameters with allowance for thermal loading.

71-1467
QUESTION ABOUT THE EFFECT OF DRY AND VISCOUS FRICTION IN THE SUSPENSION
Skinder, I.B.
Wright-Patterson AFB, Transl. Avtomobilnaya Promyshlennost (USSR), 19 pp (Dec. 28, 1970)

Key Words: shock absorbers, suspension systems

The Den Hartog solution is presented for the calculation of the amplitude-frequency characteristics of a system with a single degree-of-freedom subject to simultaneous action of dry and viscous friction. The formulas and graphs presented make it possible to determine the resistance coefficients of a hydraulic shock absorber for a known magnitude of the dry friction. Both cases in which it is possible to account for dry friction and others in which it is not are given.
AD-725010

BEARINGS

71-1468
DYNAMIC STABILITY OF GIMBALED SPIRAL-GROOVED THRUST BEARINGS
Gu, A.L.; Pan, C.H.T.; and Badgley, R.H.
Mech. Tech. Inc., 63 pp (May 1971)

Key Words: bearings, dynamic stability, spectral analysis

A general, easily implemented technique by which stability maps may be determined for gimbaled, gas-lubricated, spiral-grooved thrust bearings is described. This technique is based upon the spectral analysis (frequency domain) method, in which the neutrally stable states of the stator-gimbal system are determined through solution of the system's characteristic equations.
AD-725164

ISOLATORS
(Also see No. 1505)

PIPES

71-1469
RESPONSE OF FLUIDIC LINES AT HIGH FREQUENCIES
Krishnaiyer, R.
Instruments and Control Systems 44 (8), 84-85 (Aug. 1971)

Key Words: fluidics, high frequency response

Impedance characteristics of pneumatic transmission lines are considered in the design of low-energy fluidic and moving-part-logic control systems. Descriptive equations are experimentally verified in the low frequency region. The upstream impedance of the transmission line is found and the transfer function representing pressure gain is stated. Terms required in the computations are defined. These equations are experimentally verified for frequencies to 1 kHz.

BEAMS, STRINGS, RODS
(Also see Nos. 1422, 1431)

71-1470
NUMERICAL COMPUTATION OF THE RADIATION IMPEDANCE ON A RIGID ANNULAR RING VIBRATING IN AN INFINITE PLANE RIGID BAFFLE
Bouwkamp, C.J.
J. Sound and Vibration 17 (4), 499-508 (Aug. 22, 1971)

Key Words: impedance, rings

An expression for the radiation impedance of a rigid annular ring vibrating with uniform amplitude in a close-fitting infinite plane rigid baffle is presented. An algorithm for the numerical evaluation of this expression by electronic computer is included in the form of an ALGOL 60 procedure. A selection of numerical results obtained is included.

71-1471

A THEORETICAL STUDY OF THE DYNAMIC PLASTIC BEHAVIOR OF BEAMS AND PLATES WITH FINITE DEFLECTIONS
Jones, N.
Intl. J. Solids Structures 7(8), 1007-1029 (Aug. 1971)

Key Words: beams, dynamic response, pulse excitation, rectangular plates

An approximate theoretical procedure developed to estimate the permanent transverse deflections of beams and arbitrarily shaped plates subjected to large dynamic loads is described. The influence of finite deflections or geometry changes is retained in the analysis but elastic effects are disregarded. The particular case of a fully clamped rectangular plate acted on by a uniformly distributed dynamic pressure pulse is studied in some detail.

71-1472

INVESTIGATION OF THE NATURAL FREQUENCY OF THE NORMAL AND ELONGATION FUNCTION AND OF THE DAMPING OF THE INSTRUMENTED MODEL FUEL RODS OF THE Na 1/2 MODEL SUBASSEMBLIES
Krueger, W. and Schwemmle, R.
Natl. Sci. Abstracts, 54 pp (Dec. 1970)

Key Words: natural frequencies, nuclear fuel elements, test models

Investigations on free lateral vibration of fuel pins of the instrumented subassembly mockup of the sodium-colled fast breeder reactor design Na-1 are described. The influence of the axial distribution of spacer grids on natural frequencies and the corresponding vibration modes is calculated and verified by experiments. The influence of the radial clearance in cells of spacer grids on the change of the normal modes is investigated experimentally. The frequency response functions of the miniature pressure transducers are measured. The transducers are mounted on one pin and in the subassembly sheath for the detection of the boundary layer pressure fluctuations in the subassembly. Experimental arrangements, results of investigations, and instrumentation of the subassembly mockup are described in detail. (In German)
NSA-36993

71-1473

ACOUSTIC ENERGY TRANSMISSION FROM A ROD INTO A SEMI-INFINITE MEDIUM
Maxwell, G.G. and Hixson, E.L.
Tex. Univ., 95pp (Sept. 2, 1970)

Key Words: sound transmission, submerged structures, underwater sound

The solution of the problem of a semi-infinite, cylindrical, elastic, homogeneous rod set in an infinite baffle and radiating into a semi-infinite liquid, nonviscous medium is presented. An approximation method is utilized.
AD-720270

71-1474

FORCED VIBRATIONS OF FINITE, TRANSVERSELY ISOTROPIC RODS
Mengi, Y. and McNiven, H.D.
J. Sound and Vibration 17(3), 335-348 (Aug. 8, 1971)

Key Words: forced vibration, rods

The three-mode approximate theory which governs axisymmetric motions in transversely isotropic rods, is employed to study forced vibrations of a rod of finite length. For establishing the solution a mode superposition technique is used which exploits the orthogonality property of the modes of free vibration, First, the solution is given in terms of an arbitrary input and, following this, a specific problem is described and solved. The specific problem is one of finding the response of an isotropic rod of finite length when a normal force vibrating at a specified frequency is imposed at one end of the rod.

71-1475

TRANSVERSE OSCILLATION OF RIBBED RODS WITH A HELICAL PITCH
Novak, J. and Votruba, J.
Jad. Energ. 17(3), 73-80 (Mar. 1971)

Key Words: rods, turbulence, vibration response

The effect of helical pitch on transverse oscillation is investigated for isolated rods and rods in a bundle. Air or water is permitted to flow past the rods which are fastened at one end and supported at the other. Deformation, deflection, and vibration frequency are determined. (In Czechoslovakian)
NSA-36982

71-1476

FREE VIBRATION OF A CURVED BEAM
Petyt, M. and Fleischer, C.C.
J. Sound and Vibration 18 (1), 17-30 (Sept. 8, 1971)

Key Words: beams, curved columns, finite element technique, free vibration

Three finite element models are investigated for determining the radial vibrations of a curved beam. The investigations show that rigid body displacements should be closely represented and also that the normal and tangential representations should lead to the same strain energy convergence. One of the models is used to investigate the variation with subtended angle of the six lowest natural frequencies of beams with simply supported, hinged and clamped ends.

71-1477

BEAMS AND SHELLS WITH MOVING LOADS
Steele, C.R.
Intl. J. Solids Structures 7 (9), 1171-1198 (Sept. 1971)

Key Words: beams, Bernoulli-Euler method, elastic foundations, moving loads, shells, Timoshenko theory, transient response

The transient response of the Euler-Bernoulli beam and the Timoshenko beam on elastic foundations caused by moving loads is reviewed, using, however, a considerably simpler vector formulation with a Laplace rather than Fourier transformation. The problem of a cylindrical shell with an engulfing axisymmetric pressure wave is shown to be generally analogous to the Timoshenko beam problem. However, in contrast to the Timoshenko beam, the bar velocity is a "critical" load speed for which the response can become large. This is because of the coupling between axial and radial motion in the cylinder for the long wavelength modes.

71-1478

ON NONLINEAR VIBRATIONS OF A VISCOELASTIC BEAM
Takano, M.
Acustica 24 (6), 312-322 (June 1971)

Key Words: beams, vibration response, viscoelastic properties

It is shown how the coefficients of the one-dimensional nonlinear constitution equation of a viscoelastic material can be determined from experiments on the vibration of beams. The approximate equation for transverse motion of a beam in the nonlinear domain is obtained by a perturbation and optimal linearization method. The results are compared with those of the conventional iteration method for solving nonlinear differential equations; the comparison is quite satisfactory. The experiments confirm the validity of the assumption for the constitutive law. (In French)

PLATES AND SHELLS

(Also see Nos. 1421, 1429, 1477)

71-1479

MINIMUM-MASS DESIGN OF A PLATE-LIKE STRUCTURE FOR SPECIFIED FUNDAMENTAL FREQUENCY
Armand, J.L.
AIAA J. 9 (9), 1739-1745 (Sept. 1971)

Key Words: minimum weight design, natural frequency, optimum design, plates

A new approach is presented to the problem of the minimum-mass design of two-dimensional continuous structures which are required to satisfy a constraint of a dynamic or aeroelastic nature, expressed in the form of one or more partial differential equations. The minimization of a functional subject to constraints of this form belongs to a wider class of problems, encountered in the theory concerning optimal control of systems with distributed parameters.

71-1480

IMPULSIVELY LOADED CIRCULAR PLATES
Batr R.C. and Dubey, R.N.
Intl. J. Solids Structures 7 (8), 965-978 (Aug. 1971)

Key Words: circular plates, dynamic response

The dynamic behavior of elastic-plastic circular plates, with deflections in the range where both bending moments and membrane forces are important, is investigated. The formulation is restricted to two-dimensional and axisymmetric responses. The effect of shear deformations, rotary inertia and material strain rate sensitivity is not considered. The equations of motion are solved for small deformations from the initial flat configuration of the plate. The superposition of the successive increments in displacement and strain is carried out by referring each to the fixed global axes. Using this technique, the deformed shape of the plate and the initial velocity as a function of central deflection are computed and compared with the corresponding experimental findings.

71-1481

THE FREE VIBRATIONS OF A SPINNING CENTRALLY CLAMPED SHALLOW SPHERICAL SHELL
Beckemeyer, R.J. and Eversman, W.
J. Appl. Mech., Trans. ASME 38(3), 601-607 (Sept. 1971)

Key Words: clamped shells, free vibration, spherical shells

The free-vibration characteristics of a thin shallow spherical shell spinning about its polar axis and fully clamped by a central hub are accounted for in the formulation of the static equilibrium equations. Free-vibration equations are derived by considering small perturbations about the spinning equilibrium configuration. Both flexural rigidity and membrane restoring forces caused by spin are considered. Known techniques for the solution of stationary shell problems are extended. Plots of transverse frequency as a function of shell geometry are presented for the first two modes for shells having one and two nodal diameters for various values of inertia loading.

71-1482

FREE VIBRATIONS OF FREELY SUPPORTED OVAL CYLINDERS
Culberson, L.D. and Boyd, D.E.
AIAA J. 9(8), 1474-1480 (Aug. 1971)

Key Words: cylindrical shells, free vibration, mode shapes, natural frequencies. See Abstract 71-933 for the original of this material.

A study of the free vibration frequencies and mode shapes for freely supported oval cylindrical shells is reported. Cross section curvatures are expressed in terms of a single eccentricity parameter that allows a wide range of doubly symmetric ovals to be studied. Kinematic equations employing both the Love and the Donnell assumptions from thin shell theory are used and results of the two formulations are compared. Little difference is observed between the results obtained from the two theories for a wide range of shell configurations.

71-1483

ON THE TRANSMISSION OF SOUND WAVES THROUGH A BLADE ROW
Koch, W.
J. Sound and Vibration 18(1), 111-128 (Sept. 8, 1971)

Key Words: ducts, plates, sound waves

The problem of the transmission and reflection of plane sound waves incident upon a single cascade of finite plates is solved by means of the finite Weiner-Hopf technique. The results are given in explicit form containing an infinite number of constants. These constants, which are related to the attenuated waves in the "duct" formed by two adjacent blades, have to be determined from an infinite system of linear, algebraic equations. An iterative solution is possible and converges rapidly in most cases.

71-1484

NONLINEAR VIBRATION OF THIN PLATES
Kuo, C.P.
Iowa Univ., 106 pp (May 1971)

Key Words: nonlinear response, plates

Nonlinear analysis of the vibration of thin plates considering in-plane motion is investigated. The coupled nonlinear differential equations are fully hyperbolic if strains are tensile. The one-dimensional case is investigated by exact and approximate methods. All approximate results are consistent in period, which is a function of amplitude.
AD-725486

71-1485

COMPUTER PROGRAMS FOR PLATE VIBRATION INCLUDING THE EFFECTS OF CLAMPED AND ROTATIONAL BOUNDARIES AND CYLINDRICAL CURVATURE -- OPTION 2
Leibowitz, R.C. and Wallace, D.R.
Naval Ship R & D Ctr., 161 pp (Jan. 1971)

Key Words: clamped plates, computer programs, mathematical models, natural frequencies, turbulence

A comparative study is made of various methods for computing the free vibration modes and natural frequencies of thin plates with clamped and rotational supports and cylindrical curvature. The methods include closed form analytical, digital computer, nomographic, and graphical computations. Based on the results, preferred methods of computation are recommended. These methods are of particular value in extending previously formulated digital computer programs for obtaining the vibroacoustic response to turbulence excitation of a plate. Computer results for a particular case provide a comparison of the effect of clamped-clamped and simply supported boundaries on the vibratory response of a plate subject to turbulence excitation.
AD-724642

71-1486
DYNAMIC RESPONSE OF A PROTECTIVE SHOCK SHIELD TO NUCLEAR BLAST
Mathur, P.N. and Rodriguez, A.M.
Aerospace Corp., 30 pp (June 1, 1971)

Key Words: dynamic response, interaction: structure-foundation, nuclear explosions, plates

A simplified quasi-static plate theory is presented for analyzing the dynamic response of an infinite plate half-space structural system subjected to a traveling side-on pressure pulse. The theory is applicable to the case of finite plate structure, and provides a method of calculation of the attenuation characteristics of the plate and the time histories of the stresses and motions transmitted to the foundation media. Validity of the theory is checked against computer calculations based upon a more rigorous Fourier Transform solution and other known solutions.
AD-724904

71-1487
A UNIVERSAL DISPERSION CURVE FOR FLEXURAL WAVE PROPAGATION IN PLATES AND BARS
Nelson, H.M.
J. Sound and Vibration 18 (1), 93-100 (Sept. 8, 1971)

Key Words: bars, flexural vibration, periodic excitation, plates

If the velocity of steady-state sinusoidal flexural wave propagation in plates and bars is expressed as a fraction of the surface (Rayleigh) wave velocity in a semi-infinite medium of the same material, the number of parameters needed to define the dispersion curve is reduced to one, the Poisson's ratio of the material. Numerical data exists for one value of Poisson's ratio. A method is proposed for estimating the sensitivity of the curves to variations in the Poisson's ratio.

71-1488
FORCED AXISYMMETRIC MOTION OF CIRCULAR, VISCOELASTIC PLATES
Robertson, S.R.
J. Sound and Vibration 17 (3), 363-381 (Aug. 8, 1971)
Key Words: circular plates, rotatory inertia, transverse shear deformation, viscoelastic properties

Williams' method for forced motion of elastic systems is applied to circular, viscoelastic plates where the effects of rotatory inertia, transverse shear and time-dependent boundary conditions are included. The viscoelastic material is assumed to have a constant Poisson's ratio. A particular problem is solved for a symmetrically loaded, completely free plate. The material used is vulcanized rubber where the viscoelastic behavior in shear is used in specifying the material parameters of a three-element solid.

71-1489
VIBRATIONS OF RECTANGULAR CANTILEVER PLATES SUBJECTED TO IN-PLANE ACCELERATION LOADS
Simons, D.A. and Leissa, A.W.
J. Sound and Vibration 17 (3), 407-422 (Aug. 8, 1971)
Key Words: cantilever plates, rectangular plates, vibration response

The vast literature dealing with the free vibrations of plates contains virtually no references for plates which are loaded by acceleration fields or gravity forces in their plane. The present paper studies the case of the rectangular cantilever plate. In-plane forces caused by an arbitrarily oriented acceleration are determined by solving a plane problem of the theory of elasticity. The transverse free vibration eigenvalue problem is analyzed by the Ritz method using mode shapes [illegible] sum of products of the eigenfunctions for vibrating beams. The resulting matrix eigenvalue problem is solved by standard techniques on the digital computer.

71-1490
ATTENUATION OF WAVES PROPAGATING ALONG THE EDGE OF A PLATE
Sinclair, R. and Stephens, R.W.B.
Acustica 24 (6), 336-339 (June 1971)
Key Words: plates, Rayleigh waves, wave attenuation

Rayleigh waves are generated and detected on the edge of a metal disk. The amplitudes of these waves are measured at each excursion around the disk for frequencies up to 400 kHz and attenuation coefficients are calculated.

71-1491
A THREE-DIMENSIONAL SOLUTION FOR PLATES AND LAMINATES
Srinivas, S. and Rao, A.K.
J. Franklin Inst. 291 (6), 469-481 (June 1971)
Key Words: dynamic response, laminates, plates

A general three-dimensional solution is presented for statics and dynamics of plates, homogeneous or laminated, of orthotropic materials.

The solution is in series form. Using parts of the general solution a variety of problems, especially of rectangular configurations, can be solved. As Mindlin's approximate analysis for vibration of thick plates is often adequate for specific practical purposes, a general solution for Mindlin's analysis is also given.

71-1492

ON AXISYMMETRIC FREE VIBRATIONS OF THIN TRUNCATED CONICAL SHELLS
Valathur, M. and Albrecht, B.
J. Sound and Vibration 18(1), 9-16 (Sept. 8, 1971)

Key Words: conical shells, free vibration, rotatory inertia, series solution, transverse shear deformation

The axisymmetric free vibrations of thin truncated conical shells are studied by means of power-series solutions. Effects of shear deformation and rotatory inertia are accounted for and the results are compared with those predicted by the classical thin shell theory. It is found that the shear deformation-rotatory inertia theory predicts lower frequencies than those predicted by the classical thin shell theory, these differences being relatively greater for the shorter cones.

71-1493

INFLUENCE OF PULSE SHAPE ON THE FINAL PLASTIC DEFORMATION OF A CIRCULAR PLATE

Youngdahl, C.K.
Intl. J. Solids Structures 7(9), 1127-1142 (Sept. 1971)

Key Words: circular plates, dynamic plasticity, shock excitation

A closed-form solution is obtained for the dynamic plastic deformation of a simply-supported circular plate subjected to a pressure pulse of general shape. It is shown that the final plastic deformation is strongly dependent on the pulse shape. However, the effect of the pulse shape can be characterized by an effective pressure defined in terms of simple integrals of the pressure-time function.

COLUMNS

71-1494

DISPLACEMENT BOUNDS FOR BEAM-COLUMNS WITH INITIAL CURVATURE SUBJECTED TO TRANSIENT LOADS
Plaut, R.H.
Intl. J. Solids Structures 7(9), 1229-1235 (Sept. 1971)

Key Words: beam-columns, transient excitation

Elastic beam-columns with initial curvature and pinned or clamped ends are considered. Upper bounds on the lateral displacement response to transient axial and distributed lateral loads are derived by means of energy type functionals and some inequalities. The results are significant because of their generality.

PANELS

71-1495

SOUND AND VIBRATION TRANSMISSION THROUGH PANELS AND TIE BEAMS USING STATISTICAL ENERGY ANALYSIS
Crocker, M.J.; Battacharya, M.C.; and Price, A.J.
J. Engr. Industry, Trans. ASME 93(3), 775-782 (Aug. 1971)

Key Words: beams, panels, sound waves, statistical energy methods, vibration response

The transmission of acoustic energy through single panels, independent double panels, and double panels connected with the beams is examined. The theoretical model consists of three linearly coupled oscillators, room-panel-room, in the single panel case. The double panel case consists of five oscillators; room-panel-cavity-panel-room. In the connected case, the tie beams must be accounted for as the sixth oscillator. A coupling loss factor is determined for the ties. Both resonant and nonresonant transmission are included.

GEARS

71-1496
EFFECT OF CHANGE OF PITCH
ON GEAR NOISE
Attia, A.Y.
J. Sound and Vibration 18(1), 129-137
(Sept. 8, 1971)

Key Words: gears, noise generation

The results of an experimental investigation into the effect of the number of gear teeth on gear noise are reported. Four pairs of gears, of 6 in. pitch diameter and of different diametral pitches, are tested in a power circulating gear testing machine installed in an anechoic room. Results show that with increasing diametral pitch (other gear parameters and running conditions being the same) gear noise decreases considerably at first, tending to reach a minimum at higher pitches; the amount of noise reduction does not change with speed.

STRUCTURAL

71-1497
NUMERICAL CALCULATION OF THE
ADDED MASS AND DAMPING COEFFICIENTS
OF CYLINDERS OSCILLATING IN OR BELOW
A FREE SURFACE
Bedel, J.W. and Lee, C.M.
Naval Ship R & D Ctr., 45 pp (Mar. 1971)

Key Words: computer programs, cylinders, vibrating structures

The computer program presented provides values of the added mass and damping coefficients of infinitely long horizontal cylinders oscillating in or below a free surface. The theoretical background, general structure, details of the input and output schemes, and the program listing are included.
AD-722690

71-1498
HIGH-FREQUENCY FLEXURAL MODES
OF STRAIGHT WEDGES
Martner, J.G.; Sidhu, G.S.; and
Hanagud, S.V.
Stanford Univ., 10 pp (Oct. 9, 1970)

Key Words: flexural vibration, wedges

A theoretical and experimental study of the flexural vibrations of wide wedges that are driven at the base by ferroelectric transducers is reported. The transducers are bonded to the wedges and oriented so that flexural modes of vibration are generated. The wedges have triangular profiles; their width is larger than six wavelengths. The natural frequencies of vibration are first computed using the classical theory, which neglects the effect of rotary inertia. The results are used to check a computer implementation of the Myklestad-Prohl method.
AD-724245

SYSTEMS

STRUCTURAL

(Also see Nos. 1420, 1424, 1425, 1428, 1486, 1518)

71-1499
RESONANCE CLASSIFICATION IN A
CUBIC SYSTEM
Ness, D.J.
J. Appl. Mech., Trans. ASME 38(3),
585-590 (Sept. 1971)

Key Words: parametric excitation

A weakly nonlinear, single degree-of-freedom cubic system which is simultaneously subject to a time-varying force and parametric excitation is considered. The various types of resonance phenomena exhibited by the system are classified and a detailed stability analysis is presented for one case.

71-1500
NATURAL FREQUENCIES OF
CIRCULAR ARCHES
Wolf, J.A., Jr.
J. Structural Div., Proc. ASCE 97(ST9),
2337-2350 (Sept. 1971)

Key Words: arches, finite element techniques, natural frequencies, rotatory inertia

A study of the free vibrations of elastic circular arches is presented, demonstrating the application of a particular direct iterative eigensolution method. The model consists of a sequence of straight beam finite elements connecting nodal points lying on the circular elastic axis of the arch. The effect of rotatory inertia is included, but transverse shear deformations are neglected in the analysis. The use of a finite element model facilitates determination of energy distribution in each mode, and permits quantitative analysis of the nature of the frequency spectrum for circular arches of various slenderness ratios. Results also include tables of natural frequencies for circular arches.

71-1501

FINITE-ELEMENT ANALYSIS OF LARGE ELASTIC-PLASTIC TRANSIENT DEFORMATIONS OF SIMPLE STRUCTURES

Wu, R.W.H. and Witmer, E.A.

AIAA J. 9(9), 1719-1724 (Sept. 1971)

Key Words: finite element technique, transient response

The assumed-displacement finite element method is extended to analyze the large-deflection transient responses of simple structures. These include elastic-plastic, strain-hardening, and strain-rate material behavior. The resulting equations of motion are solved by a direct time-wise numerical integration scheme. Numerical examples are carried out for an impulsively loaded beam and an impulsively loaded ring. These are compared with both finite difference predictions and experimental results.

ACOUSTIC ISOLATION

71-1502

ECONOMIC POTENTIAL OF MINERAL BASED INSULATING MATERIALS IN COMBATING THE NOISE PROBLEM IN RESIDENCES

Cooper, F.D. and Langlois, L.M.

Bur. Mines, 28 pp (1970)

Key Words: buildings, noise reduction

Three model dwelling units are redesigned to achieve specific levels of noise reduction above that provided by conventional construction. Using 1968 prices, the added cost of materials and installation is found to range from $500 to $5,000 depending upon the size of the dwelling unit and the degree of insulation. The potential aggregate expenditures for sound insulation materials are projected to reach $617 million in 1975, including about $408 million for the mineral based materials, in 1968 constant dollars. The report includes a brief review of the mechanics and effects of sound.

PB-193247

AIRCRAFT

(Also see Nos. 1427, 1525, 1526)

71-1503

USE OF CORRELATION TECHNIQUE FOR ESTIMATING IN-FLIGHT NOISE RADIATED BY WING MOUNTED JET ENGINES ON A FUSELAGE

Bhat, W.V.

J. Sound and Vibration 17(3), 349-355 (Aug. 8, 1971)

Key Words: aircraft noise, correlation technique, noise prediction

Turbulent boundary layer pressure fluctuations and noise radiated by jet engines form two major sources of pressure fluctuations on the exterior of many commercial jet fuselages. The expressions for correlations and mean square pressures of two statistically independent noise sources are derived. A method of decomposing the two pressure fields is illustrated using flight test measurements.

71-1504

VIBRATION CHARACTERISTICS OF PRETWISTED BLADES OF ASYMMETRICAL AEROFOIL CROSS SECTION

Carnegie, W. and Dawson, B.

Aeronaut. Quart. 22(3), 257-273 (Aug. 1971)

Key Words: aerofoil, blades

The natural vibration frequencies and mode shapes of cantilever aerofoil cross section blades of pretwist angle in the range 0 to 90 deg are obtained. The beams are 152.4 mm long and the width/thickness ratio is such that they may be regarded as slender. Theoretical frequency ratios and mode shapes of vibration, neglecting shear and rotary inertia effects, are obtained for two sets of beams, one with clockwise pretwist relative to the root cross section and the other with anticlockwise pretwist. The effect of variation in the value of the center-of-flexure coordinates upon the natural frequency ratios and mode shapes of vibration is investigated. The theoretical results are compared to corresponding experimental results.

71-1505
AIR CUSHION PRESSURE DURING STIFF OPERATION FOR AIR CUSHION LANDING SYSTEM -- PART 1: THEORY
Han, L. S.
Air Force Flight Dynamics Lab., 73 pp (May 1971)

Key Words: air cushion landing systems, landing gears

This part of the report contains the theoretical treatment of the problem. The results are in the form of a cushion pressure ratio in terms of the supply (trunk) pressure. Analysis is performed based on incompressible viscous theory.

71-1506
SHOCK-CELL NOISE -- AIRCRAFT MEASUREMENTS
Hay, J.A.
J. Sound and Vibration 17 (4), 509-516 (Aug. 22, 1971)

Key Words: acoustic excitation, aircraft, fatigue

A description is given of flight test measurements designed to determine the cause of severe acoustic loading on the tail planes of early VC 10 and BAC 1-11 aircraft. This loading is found to be attributable to in-flight shock-cell noise. A convergent-divergent nozzle design, together with minor structural modifications, gives the greatest overall alleviation of the problem for these two particular aircraft.

71-1507
GUST LOADING ON A THIN AEROFOIL
Mugridge, B.D.
Aeronaut. Quart. 22 (3), 301-310 (Aug. 1971)

Key Words: aerodynamic excitation

A closed-form expression is derived which gives an approximate solution to the lift generated on a two-dimensional thin aerofoil in incompressible flow with a normal velocity component of the form $\exp\left[i(\omega t - \bar{k}_x x + \bar{k}_y y)\right]$. The inaccuracy of the solution when compared with other published work is compensated by the simplicity of the final expression, particularly if the result is required for the calculation of the sound power radiated by an aerofoil in a turbulent flow.

71-1508
NONLINEAR PROPAGATION OF SIGNALS IN AIR
Pernet, D. F. and Payne, R. C.
J. Sound and Vibration 17 (3), 383-396 (Aug. 8, 1971)

Key Words: aircraft noise

The results of a theoretical and experimental investigation into the nonlinear, planar propagation of sinusoidal and band-limited noise signals in air are presented. Signals with a fundamental frequency between 500 and 3 kHz and with sound pressure levels up to 165 dB are used in the experimental investigation and are transmitted over a distance of 60 m in a tube. The extension to spherical waves and the possible role played by nonlinearity in the propagation of aircraft noise are discussed.

71-1509
SONIC BOOMS IN THE SEA
Urick, R.J.
Naval Ordnance Lab., 21 pp (Feb. 28, 1971)

Key Words: sonic boom, underwater sound

Sonic booms created by Navy fighter aircraft flying at Mach 1.1 to 1.2 are observed below the surface of the sea by means of a string of hydrophones 195 ft long dangling from a surface ship. The underwater booms decay at about the -3/2 power of the depth below the surface, have the same spectral content as the boom in air, and travel down the string with the velocity of sound in water.
AD-725132

71-1510
NOISE FROM GAS TURBINE AIRCRAFT ENGINES
Natl. Industrial Pollution Control Council, 28 pp (Feb. 1971)

Key Words: aircraft noise, engine noise, noise reduction

The noise pollution of aircraft gas turbine engines is discussed.
COM-71-50237

71-1511
NOISE POLLUTION -- AIRPLANE NOISE (VOLUME I)
Defense Documentation Ctr., 149 pp (June 1971)

Key Words: noise, reviews, sonic boom

The annotated bibliography is an unclassified compilation of references on airplane noise pollution in a series of bibliographies on environmental pollution. References deal primarily with the effects of noise exposure on hearing, speech, communications and community/airport noise. Computer-generated indexes for corporate author-monitoring agency, subject, and title are included. Reports pertaining to sonic boom are omitted.
AD-724850

71-1512

ENVIRONMENTAL POLLUTION: NOISE POLLUTION -- SONIC BOOM (VOLUME 1)
Defense Documentation Ctr., 86 pp
(Apr. 1971)

Key Words: noise, reviews, sonic boom

The unclassified, annotated bibliography is Volume 1 of a two-volume set on sonic boom in a series of scheduled bibliographies on environmental pollution. Volume II is Confidential. Corporate author-monitoring agency, subject, title, contract, and report number indexes are included.
AD-722910

BUILDINGS
(Also see No. 1523)

71-1513

SEISMIC RESISTANCE OF PRESTRESSED CONCRETE BEAM-COLUMN ASSEMBLIES
Blakeley, R.W.G. and Park, R.
Am. Concrete Inst. J. 68 (9), 677-692 (Sept. 1971)

Key Words: beam-columns, seismic response

A series of four tests conducted on full-size precast, prestressed concrete beam-column assemblies under reversed cyclic loading of high intensity is reported. The test variables include the amount of transverse confining steel for ductility and the position of the plastic hinge in the members. It is concluded that large postelastic deformations can be attained in prestressed concrete members and that the energy dissipation at large deformations can be considerable, but only after damage has occurred.

71-1514

BUILDING COLUMNS UNDER STRONG EARTHQUAKE EXPOSURE
Blume, J.A.
J. Structural Div., Prov. ASCE 97 (ST9), 2351-2369 (Sept. 1971)

Key Words: columns, multistory buildings, seismic response

A column of a hypothetical 12-story reinforced concrete building located in an active earthquake area is analyzed in view of current knowledge. The analysis is conducted with probabilistic considerations and parameter studies of ground motion, concurrent and unidirectional response, various degrees of design reduction of cantilever overturning moment, elastic and inelastic behavior, changes in column inflection points, and variations in actual column strength. Probabilities of damage are obtained for columns designed by USD and WSD procedures under seismic code requirements and then subjected to estimated strong earthquake motion as key elements of the building.

71-1515

DYNAMIC TESTS OF A MODEL FLEXIBLE-ARCH TYPE PROTECTIVE SHELTER
Kennedy, T.E.
Army Engineer Waterways Experiment Station, 169 pp (Apr. 1971)

Key Words: dynamic testing, nuclear explosions, protective shelters, underground structures

The dynamic response of a buried model flexible-arch troop shelter to simulated nuclear blast overpressures is determined. A model structure for testing is constructed using a geometric scaling ratio of 1 to 4.5. The structure is buried in dense, dry sand with the depth of cover over the crown equal to one-fourth of the arch diameter.
AD-723960

71-1516

SONIC BOOM ANALOGS FOR INVESTIGATING INDOOR WAVES AND STRUCTURAL RESPONSE
Lin, S.
Univ. Toronto, 12 pp (Nov. 1970)

Key Words: sonic boom, structural response

Experimental results indicate that the maximum amplitude of the indoor pressure wave induced by a sonic boom for the case of a partly open window is larger than the maximum amplitude

of the incident sonic boom. In such a case, the two undesirable effects of the sonic boom are the annoyance it causes people and the fact that the effect it has upon structural members is larger indoors than outdoors.

71-1517

LONGITUDINAL MODE RESONANCES OF SHORT CYLINDERS
Massey, L. and Stephens, R.W.B.
Acustica 24(6), 330-335 (June 1971)

Key Words: cylinders, longitudinal response

The longitudinal mode resonances of short cylinders of glass, polystyrene and polymethyl methacrylate are measured and compared with the predictions of the exact theory of velocity dispersion. Observed deviations from this theory are found to be caused by (1) anisotropy of the material of the cylinder, (2) the assumption in the theory of frequency-independent Lamé elastic constants; and (3) "end effects" resulting from residual stresses in the end faces of the cylinders.

71-1518

LATERAL AND ROCKING VIBRATION OF FOOTINGS
Veletsos, A.S. and Wei, Y.T.
J. Soil Mech. Foundations Div., Proc. ASCE 97 (SM9) 1227-1248 (Sept. 1971)

Key Words: disks, footings, lateral response

Numerical data are presented for the steady state response of a rigid circular disk, or footing, supported at the surface of an elastic half-space and excited by a harmonically varying horizontal force and a harmonically varying overturning moment. The disk is considered to be massless. The response quantities evaluated include the displacements of the disk in the direction of the exciting forces, the rotation caused by the horizontal force, and the distributions of the contact stresses beneath the disk. Data are also presented for the stiffness and damping coefficients in an equivalent spring-dashpot representation of the disk-foundation system.

71-1519

TORSIONAL VIBRATIONS OF CIRCULAR FOUNDATIONS
Weissmann, G.F.
J. Soil Mech. Foundations Div., Proc. ASCE 97 (SM9), 1293-1316 (Sept. 1971)

Key Words: foundations, torsional response

Vibrations of circular foundation about their axis of symmetry are investigated. The analytical solutions of forced torsional oscillations on an elastic homogeneous isotropic half-space are modified in order to account for the internal friction of soils and slipping of the foundations. Experimental data obtained on silty clay and sand are used to verify the proposed mathematical model of forced torsional vibrations of rigid circular foundations. Simplified expressions are developed for the determination of the resonant frequency and the amplitude at resonance. Good agreement between the experimental data and the theoretically predicted values is obtained.

BRIDGES

71-1520

FATIGUE OF BEAMS WITH WELDED COVER PLATES: LOADING HISTORY OF HIGHWAY BRIDGES
Murad, F.A. and Heinz, C.P., Jr.
Maryland Univ., 187 pp (Sept. 1970)

Key Words: beams, bridges, fatigue, plates

The increased use of welded members as bridge elements, together with trends toward heavier truck gross weights and traffic volumes, necessitates the study of the behavior of welded cover-plated girders subjected to conditions of varying load amplitudes. A survey of the literature indicates the effect of the various factors which influence fatigue behavior under both constant and variable amplitude. A hypothesis, based on the assumption that the plastic strain amplitude during any given cycle of stress is an index of the induced fatigue damage, is presented.
PB-199784

EARTH

(Also see Nos. 1448, 1513, 1514)

71-1521

A COMPUTER PROGRAM FOR EARTHQUAKE ANALYSIS OF DAMS
Chopra, A.K. and Chakrabarti, P.
Calif. Univ., 78 pp (Sept. 1970)

Key Words: computer programs, dams, finite element analysis, seismic response

A general computer program based on the finite element method of analysis of linearly elastic dam cross sections subjected to earthquakes is presented. It is applicable to the analysis of

concrete gravity dams and earth dams. This program utilizes a recently developed plane stress quadrilateral element, and the equations of motion are solved by the mode superposition method using the fastest known subroutines for computation of eigenvalues and eigenvectors. The Fortran IV listing of the program is included and the usage and capabilities of the program are illustrated by examples.
AD-723994

71-1522

ACCELERATION OF CRANE TRAVERSING GEAR IN FLEXIBLE LOAD CONDITIONS
Kazak, S.A.
Russian Engr. J. L(11) 30-34 (1970)

Key Words: gears

The author proposes linear equations of motion and their solutions when the average starting force (torque) of an electric motor is constant, and when the switching operations are in accordance with a two-mass design diagram. He substantiates the recommendation of calculating the time lag in each stage, with due regard for transverse load oscillations. Instances are given where the flexibility of the load suspension necessitates an increase or a decrease of the starting power of the drive motor.

71-1523

EARTHQUAKE DESIGN FORMULA CONSIDERING LOCAL SOIL CONDITIONS
Tezcan, S.S.
J. Structural Div., Proc. ASCE 97(ST9), 2383-2405 (Sept. 1971)

Key Words: buildings, seismic design, seismic response, standards and codes

A new earthquake code formula is proposed, based on the principles of the response spectrum technique considering the local soil conditions. Six different groups of soil are defined from the viewpoint of their predominant periods. After the natural period and fraction of critical damping are estimated for a structure, the seismic forces may be evaluated by means of these idealized spectrum curves more realistically than would be possible from an existing building code formula. The soil structure period relations and the possibility of resonance which are usually overlooked in the provisions of the earthquakes codes, are duly taken into account. The formula is also intended to evaluate the seismic forces of structures other than ordinary buildings, such as bridges, dams, towers, elevated tanks, chimneys, etc. For the purpose of emphasizing the need for a new approach, the earthquake response of a hypothetical 10-story reinforced concrete building under two different subsoil conditions is included.

ENVIRONMENTS

(Also see Nos. 1432, 1507, 1512)

71-1524

FEASIBILITY STUDY OF SLANTING FOR COMBINED NUCLEAR WEAPONS EFFECTS (REVISED) (VOLUME 1)
Murphy, H.L.
Stanford Research Inst., 159 pp (Oct. 1970)

Key Words: nuclear explosions, protective shelters, weapons effects

This report covers the early stages of the preparation of a guide. It is intended to aid architects and engineers in the design of basement shelters to withstand 15 psi free field nuclear blast overpressures and associated weapon effects.
AD-724711

71-1525

METROPOLITAN AIRCRAFT NOISE ABATEMENT POLICY STUDY, JOHN F. KENNEDY INTERNATIONAL AIRPORT, NEW YORK, NEW YORK
Tri-State Transp. Com., 21 pp (1970)

Key Words: aircraft noise, noise reduction

Measures to provide relief from aircraft noise in affected communities near John F. Kennedy International Airport are considered. Recommendations are made for reducing aircraft noise problems. A study of present land use, local development policies and codes, sound insulations of structures, redevelopment, future land-use alternatives, legal aspects and airport operations is reported.
PB-200164

71-1526

METROPOLITAN AIRCRAFT NOISE ABATEMENT POLICY STUDY, JOHN F. KENNEDY INTERNATIONAL AIRPORT, NEW YORK, NEW YORK -- TECHNICAL SUPPLEMENT: NOISE-REDUCING CONSTRUCTIONS AND COST ESTIMATING IN HIGH NOISE AREAS
Tri-State Transp., 67 pp (Feb. 1970)

Key Words: aircraft noise, noise reduction

Baseline and quiet engine contour maps of the noise exposure forcase (NEF) for 1975 are examined to obtain octave-band sound-pressure

levels on the -30 (B zone) and -40 (C zone) contours, from which noise reducing structures and cost estimates were developed for existing and new buildings in these zones. The process of computing the sound-pressure levels existing at approximately ground level at 1 mi intervals on the zone contours is discussed with the results and pertinent information provided in tables.
PB-199724

HUMAN
(Also see No. 1430)

71-1527
A PSYCHOMETRIC STUDY OF NOISINESS
Rahlfs, V.W. and Schaaf, A.
Acustica 24 (6), 340-346 (June 1971)

Key Words: human factors, noise

Annoyance values of laboratory generated complex sounds are determined by a pure phychological scaling method and correlated with physical parameters by a multiple regression technique. Sound stimuli consists of a broadband noise with a superimposed narrowband component, the location and intensity of which are systematically varied. The psychophysical relations can be expressed in the form of a simple equation. (In German)

71-1528
A NOTE ON BEETHOVEN'S METRONOME
Talbot, L.
J. Sound and Vibration 17 (3), 323-329 (Aug. 8, 1971)

Key Words: musical instruments

An analvsis is made of the amount that a metronome can be slowed by friction before its motion becomes unacceptably irregular. The study was prompted by the fact that many of the metronome marks given by Beethoven for his music are considered to be too fast, and the question arises as to whether this could have been caused by frictional retardation of his metronome, causing the musician to have set his instrument at higher-than-desired frequencies. It is concluded that frictional effects conceivably could produce about a 10 percent reduction in frequency, but this amount is insufficient to explain all of the metronome marks in question.

ISOLATION
(Also see No. 1459)

METAL WORKING AND FORMING

71-1529
STUDY OF THE FRICTION PROCESS DURING VIBRATION CUTTING OF REFRACTORY ALLOYS
Wright-Patterson AFB, Transl. Izvestiya Vysshkih Uchebnykh Zavedenii, Mashinostroenie (USSR), 11 pp (Feb. 12, 1971)

Key Words: machine tools, vibratory tools

The article describes investigations of friction under conditions approximating friction along the front and rear edges of a tool during vibrational cutting (drilling), and based on study of the magnitude of normal pressure on the study of the friction pair, and on the magnitude of the cutting speed.
AD-724998

PACKAGE

71-1530
HOW VARIATIONS IN CORRUGATED-PAD COMPOSITION AFFECT CUSHIONING
Stern, R.K.
Package Engr. 16 (7), 50-53 (July 1971)

Key Words: packaging

The relationship between the shock-cushioning ability of corrugated pads and the weight of the facing and corrugating medium is studied. The weights represent the range of combinations which corrugated box manufacturers customarily use.

RAIL

(Also see No. 1463)

71-1531

COUPLED DYNAMIC INTERACTIONS BETWEEN HIGH SPEED GROUND TRANSPORT VEHICLES AND DISCRETELY SUPPORTED GUIDEWAYS

Chiu, W.S.; Woormley, D.N.; Smith, R.G.; and Richardson, H.H.

Mass. Inst. Tech., 130 pp (July 1970)

Key Words: coupled response, high-speed ground transportation, interaction: vehicle-guideway

The coupled dynamic interactions between high-speed ground transport vehicles and discretely supported guideways is investigated. Modal analysis techniques are used to determine the performance of vehicles traversing spans with distributed mass, flexibility and damping and which rest on rigid discrete supports. Results indicate that for typical advanced transportation systems, span dynamic deflections at vehicle speeds of 100 to 300 mph may ar roach values which are twice the span static de ection due to the vehicle weight. Vehicle heave accelerations may substantially exceed the desired 0.05 g level unless very strong constraints are placed upon system parameters.

PB-199136

RECIPROCATING MACHINE

71-1532

ANALYSIS OF TORSIONAL VIBRATIONS

Ramanaiah, G.V.

Automobile Engr. 61(8), 18-22 (Aug. 1971)

Key Words: automobile, torsional response

The one-node natural frequency and angular amplitudes of undamped multicylinder engine systems are evaluated by graphical methods and a matrix method developed by Gupta. The fundamental frequency and relative amplitudes of vibration of crankshafts in engines that have from four to eight cylinders can thereby be determined.

ROAD

(Also see Nos. 1453, 1464)

71-1533

CRITERIA FOR YIELDING HIGHWAY SIGN SUPPORTS

Cook, J.P. and Bodnesi, A.

Cincinnati Univ., 183 pp (May 1970)

Key Words: collision research, computer programs

The Ohio Department of Highways currently uses lightweight steel channel posts embedded in soil for mounting small and intermediate size highway signs. Whether or not these sign supports yield without causing serious injury to a vehicle occupant when impacted at various speeds and angles and in various sizes and soil support conditions is investigated. The sign supports are evaluated by a laboratory crash simulator with 40 full-scale field crash tests and a computerized theoretical analysis.

PB-200084

71-1534

DESIGN OF FIELD AND CRASH TEST PROGRAMS FOR INFLATABLE OCCUPANT RESTRAINT SYSTEMS

Leis, R.D.; Hamilton, C.W.; and Cheaney, E.S.

Battelle Memorial Inst., 96 pp (Nov. 1970)

Key Words: air bags (safety restraint systems), automobiles, collision research, energy absorption

A detailed plan for vehicle crash tests and guidelines for field tests to evaluate the effectiveness of inflatable occupant restraint systems are presented.

PB-197617

71-1535

RIDE RESPONSE OF A MODEL VEHICLE TO HARMONIC INPUTS

McClellan, D.M.

Stevens Inst. Tech., 198 pp (May 1971)

Key Words: ground vehicles, harmonic excitation, model tests, vibration response

Vehicle response to harmonic inputs is studied. The theories of mechanical vibrations and linear systems analysis are applied to one, two, and n-dimensional lumped-parameter systems to develop an orientation to the methods of obtaining theoretical system responses. Emphasis is

placed on the system transfer function, the frequency and characteristic polynomials, and the steady state response.
AD-724704

ROTORS

71-1536

PREVENTION AND ELIMINATION OF VIBRATION IN ROTARY MACHINES
Lipsman, S. L.; Muzyka, A. T.; and Lipsman, V.S.
Army Foreign Sci. Tech. Ctr., 199 pp (June 3, 1970)

Key Words: machinery, vibration isolation

A practical guide is presented for the prevention and elimination of vibrations in rotary machines of various types, fans and exhaust fans, turbine compressors and air blowers, electrical generators and engines, steam, gas and hydraulic turbines, centrifuges and separators, disintegrators and high speed mills, etc. The book contains information on determination of the causes of vibration, descriptions of means, devices and mechanisms which are used in eliminating vibrations.
AD-719501

71-1537

DISCRETE RADIATION FROM ROTATING PERIODIC SOURCES
Wright, S. E.
J. Sound and Vibration 17 (4), 437-498 (Aug. 22, 1971)

Key Words: noise, rotor blades, rotors

A theory for discrete frequency sound radiation from rotating periodic sources is described. The theory is general and can be applied to electromagnetic and acoustic radiation. The theory was basically developed for rotor noise and attempts to cover tonal noise generally from the whole family of rotors, including helicopter rotors, propellers, fans and gas turbine compressors.

SPACECRAFT

(Also see No. 1465)

USEFUL APPLICATION

(Also see Nos. 1448, 1454, 1455)

71-1538

SYNTHESIZING MUSICAL SOUNDS BY SOLVING THE WAVE EQUATION FOR VIBRATING OBJECTS: PART II
Hiller, L. and Ruiz, P.
J. Audio Engr. Soc. 19 (7), 542-551 (July/Aug. 1971)

Key Words: music

Difference equations for vibrating objects are solved by means of a standard iterative procedure with the aid of a computer and utilized for synthesizing musical sounds.

71-1539

CONTACT AREA OF VIBROBURNISHED SURFACES
Shneider, Yu. G.
Russian Engr. J. L (11), 74-76 (1970)

Key Words: vibroburnishing

Formulae are given for determining the number of contact spots on cylindrical and flat surfaces over a given area. It is shown that vibroburnishing is superior to scraping in producing surfaces with the necessary number of contact spots, an important feature from the contact aspect in electrical and thermal conductivity.

AUTHOR INDEX

BOOKS

WAVE PROPAGATION IN SOLIDS
American Society of Mechanical Engineers,
New York, N. Y. (1970)

At the winter annual meeting of ASME held in Los Angeles in November 1969, the Applied Mechanics Division sponsored a symposium on the transmission of stress waves in solid media. Organized by Professor Julius Miklowitz of the California Institute of Technology, the symposium was composed of two sessions, the first was on linear elastic wave propagation and the second on nonlinear elastic and inelastic stress waves. Each session consisted of three papers presented by leading experts in their respective fields of research, and the total of six papers, representing the proceedings of the symposium, were published in this paper-bound volume by ASME.

The first of the elastic wave papers, by Leon Knopoff of U.C.L.A., is entitled "Elastic Wave Propagation in a Wedge." It discusses the various techniques that have been successfully applied to solve the scalar problems of waves in wedges, including the half-plane case when the wedge angle becomes 2π. The vector, elastic wave problem is still unsolved and Knopoff explains the difficulties and indicates various approximate solutions, some of which he has contributed himself. Professor Miklowitz's paper, "Analysis of Elastic Waveguides Involving an Edge", presents the analysis for determining asymptotic solutions for unidirectional, transient, wave motion in a semi-infinite plate. The chapter by Richard Scott of the University of Michigan entitled "Transient Anisotropic Waves in Bounded Elastic Media" discusses the techniques for analyzing wave propagation in anisotropic waveguides.

In part 2 on nonlinear waves, E. Varley and M. P. Mortell of Lehigh University and A. Trowbridge of Nottingham University present a paper, "Modulated Simple Waves: An Approach to Attenuated Finite Amplitude Waves." They focus on the propagation of nonlinear waves in elastic and viscoelastic materials. The second paper by E. H. Lee of Stanford University, "Some Recently Developed Aspects of Plastic Wave Analysis", is concerned with plastic waves for one-dimensional stress and strain in addition to unidirectional plastic waves resulting from combined stresses. The final paper of the symposium, contributed by Walter Herrmann of Sandia Laboratories, is on "Nonlinear Stress Waves in Metals." Herrmann examines the nonlinear theory of waves in metals and presents the methods that have been used in the analysis and in experiments.

Each of the six papers is mathematical and is aimed at the serious and advanced researcher in the particular subject covered. Of particular importance to workers in one or more of these areas, is that the papers not only teach modern developments in the fields, but they also thoroughly review the previous work and list extensive bibliographies. An exception to this is Varley, Mortell, and Trowbridge who omit such a review in their paper and dwell only on their own work on nonlinear elastic waves.

Naturally, six subspecialties within the field of stress wave propagation is not exhaustive and thus the present book does not fulfill the current need of a comprehensive reference of this subject (nor was it intended to do so). However, it is an important step in the proper direction of presenting in-depth coverages of topics that cannot be found in texts or reference books, but instead must be ferreted from the vast number of technical journals.

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VIBRATION OF ELASTIC SYSTEMS
Y. Jullien
(1970)

This excellent monograph on vibration of elastic systems is composed of three parts: the first dealing with the general mathematical theory of elasticity, the second with vibrations of continuous systems, and the third with principal applications of the theory of vibrations to practical problems. Five appendixes deal respectively with tensor calculus, strain tensor, stress tensor, thick plates theory, and vibrations of thin shells. Practical examples are included in each chapter to illustrate the theories presented.

This book, which is the result of the author's delivering lecture courses during many years to graduate students of the Faculty of Science at the University of Aix-Marseilles, presents the various subjects in a concise but very clear and well-balanced way. It will be of interest and value not only to students of acoustics and to a broader class of researchers but also to practicing engineers.

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PAPERS AND REPORTS

NEW OBSERVATIONS ON TONE GENERATION IN FANS
Mather, J.S.B.; Savidge, J.; and Fisher, M.J.
J. Sound and Vibration 16(3), 407-418
(June 8, 1971)

Refer to Abstract 71-1137

The usual procedure in the analysis of fan noise is to subdivide the noise signature into pure tone components at harmonics of blade passage frequency and a broadband contribution generally assumed to be attributable to turbulent flow phenomena. Tyler and Sofrin (Ref. 1), in a classic work, analyzed the pure tone component of the rotor signal and its subsequent propagation through a duct. They concluded that any radiation of sound under subsonic conditions is a result of rotor-stator interaction resulting in the propagation of a select number of modes at multiples of blade passing frequency. Operation at a tip Mach number exceeding some critical value, which is always greater than unity, eliminates the necessity for an interaction process. The pressure pattern associated with an isolated supersonic rotor will propagate in its own right at all multiples of blade passing frequency.

This paper extends the classis work of Tyler and Sofrin by noting that the original work assumed an identical set of rotor blades. However variations in blade camber, angles of incidence, differential untwist, etc. result in variations in the pressure signal with the passage of each blade past a fixed point. These small discrepancies can grow during transmission because of nonlinear acoustic effects. The net result is a fundamental period corresponding to the time required for one revolution of the rotor, or a fundamental frequency equal to rotor speed rather than the blade passage frequency. For example, the first mode to propagate at all rotor speeds would be at a frequency equal to the product of the number of stator vanes and the rotor frequency. The Tyler-Sofrin theory predicts that the first modal frequency would be the number stator vanes time the blade passing frequency.

Experimental data, proceeded by narrowband analysis does indeed indicate multiple tones. Acoustic data from three different experimental compressor rigs are presented and several conclusions are drawn. Forward arc noise from a supersonic compressor is found to be predominated by the rotor pressure field. The presence or absence of outlet guide vanes has little effect on the noise field. In the rear arc OGV's are a prerequisite for the observation of multiple tones. Experimental results from subsonic compressors confirm that: (a) an additional set of tones corresponding to the harmonics of shaft rotational frequency are produced: (b) the harmonic corresponding to the vane number is a plane wave and will propagate at all speeds; (c) subsonic operation sets a lower limit on the frequency at which pure tones can be observed.

The major conclusion of this paper is that modern fans contain more tonal energy than is predicted by classical theory. How pertinent this isolated piece of information is in practice will depend on the particular application.

REFERENCE

1. Tyler, J.M. and Sofrin, T.G. "Axial Flow Compressor Noise Studies", SAE Trans., pp 309-332 (1961).

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EQUIVALENT SPRING-MASS SYSTEM FOR NORMAL MODES
Bamford, R.M.; Wada, B.K.; and Gayman, W.H.
Jet Propulsion Lab., 45 pp (Feb. 15, 1971)
Refer to Abstract 71-856

The paper describes a renormalization process for each normal mode of a structural subsystem such that its reactions on another subsystem, to which it is attached at a single point, are represented by those of a corresponding single degree-of-freedom spring-mass system.

The information is put in a form so that most structural analysis computer programs can be used to evaluate the normal modes of the overall system. Because only the lower overall resonant frequencies usually are of interest, the approach significantly lowers the number of independent variables.

In addition to the spring-mass systems, one per mode, a residual mass matrix is derived to represent the contribution of the truncated modes to the rigid-body mass properties of the subsystem. In the examples, calculations of the residual mass matrix are shown to be useful as a guide to engineering judgment in mode truncation.

The technique uses well-known concepts and is developed for a cantilevered beam attached to another subsystem, assuming the beam's generalized mass matrix and resonant frequencies are available. As an example, a model of a Spacecraft is developed which is attached to a launch vehicle and has a 139th order mass matrix. Up to 42 modes are considered in the model.

The technique provides physical insight into the effect of a complex subsystem at its point of attachment to another subsystem, but the assumption of only one such point appears to restrict applicability of the technique.

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ORIGINS OF RECIPROCATING ENGINE NOISE -- ITS CHARACTERISTICS, PREDICTION, AND CONTROL
Anderton, D.; Grover, E.C.; Lalor, N.; and Priede, T.
ASME Hq. (1970)
Refer to Abstract 71-815

The authors have made a successful attempt in identifying the different sources of engine noise which are generally clubbed together and the observations of which are subjective.

The increase of engine noise with speed is related to the rate of pressure rise rather than to the combustion system employed. Their findings indicate that the noise spectrum of a two-stroke cycle and four-stroke cycle for equal pressure rise are different.

Structural noise of different configurations exhibit the same vibration characteristics, but the vibration amplitude differs. The overall noise level is governed by the stroke bore ratio rather than by the configuration. By properly controlling the pressure crank angle diagram and the structural configuration of the engine the overall noise level can be brought down,

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VIBRATION STUDY OF CLAMPED-FREE ELLIPTICAL CYLINDRICAL SHELLS
Sewall, J.L. and Pusey, C.G.
AIAA J. 9(6), 1004-1011 (June 1971)
Refer to Abstract 71-1078

The paper focuses attention on a delightful marriage of experimental data and analytical findings on the vibration of clamped-free elliptical cylindrical shells. The majority of work

to-date on cylindrical shells has dwelled primarily upon circular shapes with almost total disregard of noncircular shapes. This paper conveniently fills in the existing gap by comparing both experimental data and theoretical analysis via carefully conducted tests.

The analytical portion employs the modal function analysis based upon Rayleigh-Ritz procedure and utilizes J. L. Sander's modification of thin shell theory with further assistance by the well-known beam type functions. The results are highly illuminating with almost unbelievable correlation at the higher frequencies. Another noticeable point of information is the difference in experimentally determined frequencies between the mechanical shaker and the airjet. The latter is lower but in no case is the difference greater than 6 percent and this occurs only at the lower frequencies. This again points out the versatility of the acoustic type shaker as a good vibration exciter. Another bit of information is the better agreement between theory and experiment at lower eccentricities, i.e., $[1 - (b/a)^2]^{1/2}$ of the elliptical cylinder when compared at higher eccentricities. As a result of reviewing a number of papers on shell theory, the reviewer believes that orthogonal functions other than beam functions could be utilized and in all probability result in better accuracy and convergence with less computational effort. In summary, this is an excellent paper but additional experimental data should be obtained from other type boundary conditions and compared in a joint effort with analytical methods.

H. Saunders

FLEXURAL VIBRATIONS OF FLUID-FILLED CIRCULAR CYLINDRICAL SHELLS
Kumar, R.
Acustica 24(3), 137-146 (1971)
Refer to Abstract 71-1070

Elastic-fluid interactions have been an increasingly important subject in recent years. Most of the previous researchers in this area were concerned either with the dynamic interactions between elastic pressure vessels and the surrounding fluid medium or with the vibrations of fluid-filled tanks. In this paper, the vibrations of an infinitely long, fluid-filled circular cylindrical shell are studied. Three-dimensional equations of linear elasticity are used for both the shell and fluid and the frequencies of vibration are obtained using standard procedures.

Bliech and Baron in a previous study found that the maximum number of real frequencies for a thin circular cylindrical shell immersed in an infinite acoustic medium never exceeds that of the shell in vacuo. It is interesting to note that extra modes of vibration exist for thin, fluid-filled shells and that the number of extra modes increases with a decrease in shell thickness.

Another interesting result is that, in the attenuating region, the fluid-filled shell behaves like either the empty shell or a fluid column with rigid walls. Rand and DiMaggio previously obtained a similar result for fluid-filled spheroidal shells.

Using extensive numerical calculations, the author concludes that the influence of the contained fluid on the vibrational characteristics of the shell increases as the thickness of the shell is decreased and that this effect is more pronounced in the propagating region than in the attenuating region. Intuitively, these conclusions can be readily derived.

This paper has presented numerous numerical results and might prove useful to experimenters in this field.

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THE DAMPING EFFECTS OF VISCOELASTIC MATERIALS -- PART 1: TRANSVERSE VIBRATIONS OF BEAMS WITH VISCOELASTIC COATINGS
Baumgarten, J.R. and Pearce, B.K.
J. Engr. Industry, Trans. ASME 93(2), 645-650 (May 1971)
Refer to Abstract 71-1161

The authors propose an engineering approach to determine the natural frequencies and composite loss factors of an elastic beam having a viscoelastic layer adhered to one or both sides. They assume that the beam vibrates in the undamped mode shape of a free-free beam and

that the viscoelastic material obeys a Voigt model having a spring and dashpot in parallel. In addition, they constrain the system to vibrate according to $e^{-\alpha t} \sin \omega_m t$. Using these assumptions, they equate the change of the kinetic energies (measured at zero displacements) to the energy dissipated by the assumed dashpot, and obtain a cubic equation for the composite loss factor in terms of the geometrical and physical properties of the system. Since the results are limited to a system having a small amount of damping, the cubic equation is reduced to a linear one.

The resulting expression is a good approximation for a system having a small amount of damping and indeed, the authors' Eq. (21) represents this case. But Eq. (21) can be shown to reduce to the expression derived by other authors (Refs. 1-4), namely,

$$\eta = \frac{E_d I_c}{E_b I_b + E_s I_c}$$

where η is the composite loss factor, and:

- E_s - stored part of Young's Modulus for the viscoelastic material,
- E_d - loss part of Young's Modulus for the viscoelastic material,
- E_b - Young's Modulus of elastic material,
- I_c - area moment of inertia of viscoelastic layer about composite neutral axis,
- I_b - area moment of inertia of elastic layer about composite neutral axis.

Additionally, the derivation by other authors shows that the composite loss factor for this configuration is independent of the mode shape. Further work by Nicholas (Ref. 2) considers the added effects of rotatory inertia and shear deformation to the Oberst beam and shows the discrepancy in neglecting these additional effects.

Although not contributing new analytical knowledge to this area, the authors have conducted tests on free-free steel and aluminum bars coated with Buna-N, plexiglass and styrofoam, and they show good agreement between test and theory.

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2. Nicholas T., "The Effects of Rotatory Inertia and Shear Deformation on the Flexural Vibrations of a Two-Layered Viscoelastic-Elastic Beam", Shock Vib. Bull. 38 (III) (Nov. 1968)

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THE ANALYSIS OF SOME INTERMITTENT CONTACT DEVICES

Gladwell, G.M.L. and Mansour, W.M.
J. Sound and Vibration 15(4), 495-507
(Apr. 22, 1971)

Refer to Abstract 71-860

This article deals with the analysis of an intermittent contact device used for sonic riveting. The device employs a loose tool which impacts the work on one side and a sinusoidally excited piezoelectric crystal on the other side. The essential feature of this system is that it contains one element (the loose tool) which is not coupled at all times to the remainder of the system. The result is a nonlinear system which changes its configuration as a function of time and initial conditions.

Systems of this type, which contain connections with clearances, have been receiving increased attention in the recent literature (A. Y. Kobrinskiy 1969 and S. Dubowsky and F. Freudenstein 1971).

The authors have modeled the mechanism using a one-dimensional chain of rigid masses, massless springs, and clearances which T. P. Goodman (1963) has termed a "boxcar diagram." The system is unique in that it contains four possible dynamic configurations for one clearance connection, as opposed to most machine clearance problems which are described by three configurations for a single clearance connection.

The equations of motion for each configuration are simple, linear ordinary differential equations with constant coefficients. The state of the system determines which set of equations is applied and when the transitions occur between successive configurations. The solution to this piecewise linear problem is solved using both analog and digital computers. The authors found, as have other researchers, that the latter approach requires excessive computer time and relies mainly on analog computation. An equally acceptable solution could also be achieved on the digital computer had continuous system simulation techniques been employed, rather than the solution matching approach that was selected.

The results of the analysis are plots of the forces within the system as functions of time. These curves show the peak forces in the system to be substantially greater than the average forces. This force amplification is a desirable feature in riveting devices. The authors do not show how much of this amplification is caused by the presence of the clearance as opposed to simple linear dynamic effects.

The stated purpose of this work was to show how such loose tool devices could be analyzed and to obtain qualitative information on them, rather than quantitative results. Using this statement as justification, the authors neglected dissipation within the system. In actuality, dissipation will have a very important effect, not only on the quantitative results but on the basic form of the behavior of the system. The lack of these terms may explain some of the results which were obtained and which were unexpected by the authors. These unexplained results are the apparent random form of the output when excited by a single forcing frequency. This output is described by the author as looking similar to the output of a system with a random input. It is well known that although a linear system will respond at the forcing frequency, the response of a nonlinear system of this type will contain not only the forcing frequency but, in addition, higher harmonics. These harmonics will in turn generate additional components which recombined, produce both high and low frequency terms in the solution. The result has the appearance of wide bandwidth noise.

Real systems of this type will always contain some damping. For such nonlinear systems, analysis has shown that the effect of even small amounts of damping is to greatly attenuate the high frequency components of the solution, which is this case is probably masking the true response of the system.

In conclusion, this paper represents a significant contribution to the study of devices containing clearances. The value of this work could be extended by the addition of damping to the model, and by the use of the simulations developed to obtain the effects of varying the system's parameters on the basic behavior of such loose tool devices.

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DYNAMIC BUCKLING OF CYLINDRICAL SHELL

Cromer, C. C., and Ball, R. E.
J. Eng. Mech. Div., Proc. ASCE 97 (EM3), 657-671 (June 1971)

Refer to Abstract 71-1065

This paper discusses application of a computer program to the weakly nonlinear, elastic response calculation of a simply-supported nearly circular cylindrical shell under uniform, exponentially decaying, radial pressure. References to previous analysis of the same shell and similar loading are presented. Excitation and pressure are selected for examination of dynamic stability.

A sketchy treatment of the analysis is presented; details are left to a dissertation reference. A Donnell type shell theory that accounts for both radial inertia and shell geometric imperfections is used. Displacements consist of axisymmetric radial deformations and asymmetric flexural modes. Coupling of the radial displacements and flexural modes is retained; all other coupling is discarded. Justification, based upon the orders of magnitude of retained and discarded terms, would have strengthened the presentation.

The imperfection distribution is assumed to be representable in a separable Fourier series,

$$\overline{W} = \sum_{n=1}^{\infty} \overline{W}^n \cos n\theta \sin \frac{\pi x}{\ell}; \qquad (1)$$

as is the radial displacement

$$w = w^o + \sum_{n=1}^{\infty} w^n \cos n\theta \sin \frac{\pi x}{\ell} \qquad (2)$$

where w^o is initial displacement. The longitudinal periodicity constraint is noteworthy.

Analysis appears to be of the Galerkin type which uses the simple support boundary conditions to advantage. Second-order coupled sets of differential equations of an elementary form are obtained. Solution of the first (n=0) uncoupled equation is

$$w^o = \frac{P_o \tau_o^2}{1+\tau_o^2} (e^{-\tau/\tau_o} - \cos \tau + \frac{1}{\tau_o} \sin \tau), \qquad (3)$$

and the generalized coordinates w^n $(n \geq 1)$ are determined from

$$\ddot{w}^n + n^2 (P_{cr} - w^o) w^n = n^2 w^o \frac{\overline{W^n}}{a} \qquad (4)$$

where P_{cr} is static buckling pressure, a is radius, and τ is nondimensional time. For $P_{cr} < w^o$, instability, termed "hyperbolic modes", occurs. In this section the authors discard the two harmonic terms in Eq. (3) for the prediction of hyperbolic modes using the argument that lower frequency w^n modes should not respond appreciably to the higher frequency of w^o. This justification appears to be purely intuitive, problem dependent, and not general or mathematically precise. Next the harmonic terms are retained in Eq. (3) and substituting into Eq. (4) precedes a discussion of "Mathieu Modes" instability. Although this equation is not a Mathieu equation, the assumption of $\tau_o \gg 1$ and $\tau \gg \tau_o$ $(\exp(-\tau/\tau_o) \to 0)$ permits an approximate representation by a Mathieu equation. However, because the authors did not restrict themselves to $\tau \gg \tau_o$, the representation as a Mathieu equation is obviously not justified to the reviewer. The procedure must be considered a rather rough approximation based upon a quasi-static assumption that $\exp(-\tau/\tau_o)$ is slowly varying in the τ interval of interest. The numerical integration presented supports this approach even though the integration interval is $0 \leq \tau \leq \tau_o$. The nonlinear coupling is observed to be insignificant.

The paper is written for the specialist engineer who is interested in the specified problem. Generalization of these results or techniques will not be easy, and application to even neighboring configurations must be approached with caution.

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EFFECTS OF TRANSVERSE SHEAR AND ROTATORY INERTIA ON THE COUPLED TWIST-BENDING VIBRATIONS OF CIRCULAR RINGS

Rao, S.S.
J. Sound and Vibration 16(4), 551-566
(June 22, 1971)

Refer to Abstract 71-1188

In the past, the vibration of circular rings or arcs has been studied in connection with various practical problems ranging from the vibration of bearing races and gear noise to the vibration of curved girders used in bridge construction. In the present paper, no particular application is discussed but the analysis given is of a general nature and should have applicability to many practical situations.

The equations of motion for the in-plane and out-of-plane flexural vibrations, including the effects of rotatory inertia and shear deformation, are derived for circular rings using Hamilton's principle. Simplified forms of these equations, neglecting shear and/or rotatory inertia, are also presented. These equations are used to study the effects of shear and rotatory inertia on the natural frequencies of vibration of free rings of varying dimensions and elastic properties, of rings transversely supported at equal intervals around their circumferences and of arcs subtending various angles and having clamped or simply supported ends.

The natural frequencies obtained for the free rings are compared with available experimental results and it is shown that the most meaningful predictions are obtained by including the effects of both shear and rotatory inertia. No comment is made as to when the shear and rotatory inertia effects become significant; but this may be determined by close study of the results presented.

The results given for the supported rings and arcs represent new information hitherto not available in the literature. The paper is relatively easily followed and should be of value to both the engineer with practical problems involving ring vibrations and to the research engineer with an interest in this area.

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Technical Notes

Armaly, B. F. and Madsen, D. H.
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J. Heat Transfer, Trans. ASME 93 (2), 239-240 (May 1971)

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AIAA J. 9 (9), 1855-1858 (Sept. 1971)

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Acustica 24 (6), 354-356 (June 1971)

Cherchas, D. B.
DYNAMICS OF SPIN-STABILIZED SATELLITES DURING EXTENSION OF LONG FLEXIBLE BOOMS
J. Spacecraft and Rockets 8 (7), 802-804 (July 1971)

Dickinson, S. M.
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J. Appl. Mech., Trans. ASME 38 (3), 699-700 (Sept. 1971)

McKinney, J. M.
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Aeronaut. J. 75 (725), 339-343 (May 1971)

Ramsey, H.; Johnson, D.; and Hazell, C.R.
EXPERIMENTAL INVESTIGATION OF NONLINEAR COUPLED VIBRATIONS IN ELASTIC COLUMNS EXCITED AT HIGH FREQUENCIES
J. Mech. Engr. Sci. 13 (3), 224-226 (June 1971)

Shoup, T. E.
SHOCK AND VIBRATION ISOLATION USING A NONLINEAR ELASTIC SUSPENSION
AIAA J. 9 (8), 1643-1645 (Aug. 1971)

Tondl, A.
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J. Sound and Vibration 17 (3), 429-436 (Aug. 8, 1971)

THE ACCURACY OF LABORATORY MEASUREMENTS OF TRANSMISSION LOSS
J. Sound and Vibration 16 (4), 643-644 (June 22, 1971)

THEORETICAL ATTENUATION OF SOUND IN A LINED DUCT: SOME COMPUTER CALCULATIONS
J. Sound and Vibration 17 (2), 283-286 (July 22, 1971)

CALENDAR

Meeting	Date 1971	Location	Abstract Deadline	Contact
	DEC.			
Ultrasonics Symposium, IEEE	6-8	Miami Beach, Fla.	-	R. M. Emberson, IEEE Hq.
Vehicular Technology Conference, IEEE	7-9	Detroit, Mich.	-	IEEE Hq.
	1972 JAN.			
Automotive Engineering Congress and Exposition, SAE	10-14	Detroit, Mich.		W. I. Marble, SAE Hq.
Reliability Symposium, IEEE, ASQC, ASNT, IES	25-27	San Diego, Calif.	-	R. M. Emberson, IEEE Hq.
Winter Power Meeting, IEEE	30-4	New York, N. Y.	Sept. 15	IEEE Hq.
	MAR.			
International Association for Shell Structures Meeting, IASS	3-6	Calgary, Canada	-	Secretariat, c/o IASS Committee, Univ. Calgary, Dept. CE, Calgary, Canada
Joint Railroad Conference, IEEE, ASME	14-15	Jacksonville, Fla.		H. J. Betts, Canadian Natl. Railway, 935 Lacauchetiere St., Montreal 3, Canada
International Convention and Exhibit, IEEE	20-23	New York, N. Y.	-	J. M. Kinn, IEEE Hq.
Conference on Theoretical and Applied Mechanics, Committee for SE Conf. on Theoretical and Appl. Mech.	23-24	Tampa. Fla.	-	Dr. J. Griffith, Dept. SMF, Univ. S. Fla., Tampa, Fla.
Gas Turbine Conference and Products Show, ASME	26-30	San Francisco, Calif.	-	A. B. Conlin Jr., ASME Hq.
	APR.			
13th Structures, Structural Dynamics and Materials Conference, AIAA/ASME/SAE	10-12	San Antonio, Tex.	Aug. 6	Meetings Manager, AIAA Hq.
Diesel and Gas Engine Power Conference and Exhibition, ASME	16-20	St. Louis, Mo.	-	V. A. Smyth, ASME Hq.
Spring Meeting, ASA	18-21	Buffalo, N. Y.	Jan. 18	Betty H. Goodfriend, ASA Hq.
Annual Structural Engineering Meeting, ASCE	24-28	Cleveland, Ohio	-	W. H. Wisely, ASCE Hq.
	MAY			
Power Instrumentation Symposium, ISA	May	Dallas, Tex.	Past	A. A. Syriotis, Bechtel Corp., Box 58587, Los Angeles, Calif. 90058
National Telemetering Conference, IEEE	1-5	Houston, Tex.	-	IEEE Hq.
Design Engineering Conference and Show, ASME	8-11	Chicago, Ill.		M. Jones, ASME Hq.
Joint Computer Conference, IEEE, AFIPS	15-18	Atlantic City, N.J.	-	D. R. Cruzen, AFIPS Hq.
Mid-Year Meeting, SAE	15-19	Chicago, Ill.	-	W. I. Marble, SAE Hq.
Spring Meeting and Exposition, SESA	23-26	Cleveland, Ohio	-	B. E. Rossi, SESA Hq.
	JUNE			
Joint Automatic Control Conference, AIAA, AIChE, ASME, IEEE, ISA, Simulation Councils	June	Stanford Univ. Stanford, Calif.	Jan.	D. B. DeBra, Stanford Univ., Stanford, Calif. 94305
Lubrication Symposium, ASME	1-3	Boston, Mass.	-	P. Drummond, ASME Hq.
Annual Summer Meeting, ASME	11-14	Washington, D.C.	-	A. B. Conlin Jr., ASME Hq.
75th Annual Meeting, ASTM	25-30	Los Angeles, Calif.	Oct. 15	J. B. Bidwell, ASTM Hq.
Applied Mechanics Conference, ASME	28-28	La Jolla, Calif.	-	A. B. Conlin Jr., ASME Hq.
	OCT.			
Industrial and General Applications Group Annual Meeting, IEEE	[illegible]-12	Philadelphia, Pa.	-	J. A. Herrmann, ITE Circuit Breaker Co., 1900 Hamilton St., Philadelphia, Pa. 19130
Annual Environmental Meeting, ASCE	18-20	Houston, Tex.	-	W. H. Wisely, ASCE Hq.
Fall Meeting, SESA	17-20	Seattle, Wash.	-	B. E. Rossi, SESA
	NOV.			
Fall Joint Computer Conference, AFIPS	14-16	Las Vegas, Nev.	-	D. R. Cruzen, AFIPS Hq.
Fall Meeting, ASA	27-1	Miami Beach, Fla.	Aug. 28	M. Kronengold, Inst. Marine Sci., Rickenbacker Causeway, Miami, Fla. 33149

ADDRESSES OF SOCIETY HEADQUARTERS

AHS: 30 E. 42 St., New York, N.Y. 10017
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AOA: 819 Union Trust Bldg., Washington, D.C. 20005
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